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ABSTRACT

This report presents the methodology for short-run forecasting of personal income and employment in Hawaii. The econometric model developed in the study is used to make actual forecasts through 1973 of income and employment, with major components forecasted separately. Several sets of forecasts are made, under different assumptions on external conditions, demonstrating the model's value in comparing the effects of different government policies. Sample forecasts for the 1966-68 period which were made as a test of the model's predictive powers show that the model is quite accurate, especially in projecting employment. (BH)

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AN ECONOMETRIC MODEL FOR FORECASTING INCOME AND EMPLOYMENT IN HAWAII

by

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Economic Research Center
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June 1970

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FOREWORD

This report presents the results of a research project to develop methodology for short-run forecasting of civilian personal income and employment of Hawaii. It develops an econometric model for the Hawaiian economy and uses it to make several sets of forecasts for the years 1971-73.

The efficiency of the estimated model is quite encouraging providing some confidence in the reported forecasts. While we hope that these forecasts will be helpful to public as well as private decision makers a great deal of uncertainty currently surrounds a number of predetermined variables. For this reason our intention is to update the forecasts periodically as new information about the predetermined variables becomes available.

The model, however, has broader applications. It may be used to predict the effect of any change in the external conditions represented in the model by exogenous variables. The predicted effects, in turn, may have important policy implications. This is especially true in cases where exogenous variables are subject to direct governmental controls or may be influenced by public policy. The model may also be used to the effectiveness of public policies.

Walter Miklius
Director

June 1970
Honolulu

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Miss Jane Harris edited the entire draft and made significant improvements in the language as well as the presentation. The demanding task of typing the difficult manuscript was performed by Mrs. Jean Taga and Mrs. Karen Higa. They did it with patience and efficiency.

Needless to say, the author is responsible for whatever shortcomings remain in the study.

Laurence Chau

June 1970

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CHAPTER I

INTRODUCTION

Objectives

This study seeks to construct a system of relations, or an economic model, for making short-run forecasts on civilian personal income and employment of Hawaii. Specifically, we will make several sets of forecasts for the years 1969 to 1973 under alternative assumptions on external conditions.

Our approach differs from most existing forecasts for the State in two important aspects. First, instead of forecasting personal income and employment as aggregates, we forecast their major components separately. Secondly, most other forecasts are based on judgment or some extrapolation of past experiences. Our forecasts are defined by a set of functional relationships which specify all the important underlying factors as well as how they operate. While it does not necessarily follow that our forecasts will always be closer to the mark than the "naive" ones, this approach enables us to learn from error as well as to incorporate effects of changes in internal and external circumstances more effectively. As will be demonstrated, we can pinpoint what went wrong in past forecasts in order to make adjustments. The effect of a new development can be analyzed in terms of its influence on various underlying factors and its impact on the relationship between these factors and income and employment. We may, therefore, expect our approach to be more efficient in repeated applications.

The results of our study can also be used to evaluate the effectiveness of economic policy. The impact of such public activities as changes in

federal employment in the State or changes in expenditures of state and local government can be measured. The model also provides answers for many questions of important policy implications, such as: What is the income and employment generating effect of the growth of the visitor industry? How great will the pressure be on the labor market for a given acceleration of the rate of growth?

Nature and Uses of an Econometric Model

Econometric models have been used extensively at the national level to analyze and to forecast the course of the economy. Its use at the regional or state level, however, is recent and sporadic. Since this study represents a first attempt at formulating and estimating an econometric model for the entire economy of Hawaii,[1] a brief description of an econometric model as a research tool is perhaps in order.

The following building blocks go into the structure of an econometric model:

variables - endogenous, exogenous

functional forms (model)

data and a technique of estimation

structure - structural form and reduced form

The researcher first determines the set of economic activities to be explained by the model. Variables measuring the levels of these activities are referred to as endogenous variables. Other activities or factors which

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[1]Two econometric studies dealing with particular aspects of the Hawaiian economy were published. In 1963, Ferber and Sasaki completed a study for projecting employment and wages [4], and in 1969 Norman and Russell finished a study for forecasting state tax revenue [10].

are not of an economic nature or which are beyond the scope of the model are designated by a set of exogenous variables. By definition, exogenous variables are not affected by endogenous ones. Given the continuative nature of many activities, the course of endogenous variables may also be shaped by the lagged values of some endogenous variables. Exogenous variables and lagged endogenous variables are jointly referred to as the predetermined variables. At any given time, they represent the situation or 'stimulus' given from outside as well as historical data to which the economy responds.

Generally, an endogenous variable responds not only to predetermined variables but to some other endogenous variables as well. Symbolically, the determination of a particular economic activity may be written as

$$y_i = \beta_{i0} + \beta_{i1} z_1 + \ldots + \beta_{ik} z_k + \alpha_{i1} y_1 + \ldots + \alpha_{im} y_m + \epsilon_i$$

where $z_1, z_2, \ldots z_k$ refer to the set of predetermined variables and $y_1, y_2, \ldots y_m$ refer to the set of endogenous variables other than y_i; the β's and α's are parameters measuring the direct effect of y_i of a unit change in these other variables; and ϵ_i is the residual. Of course, not all endogenous variables and exogenous variables contributed to a change in y_i. Some β's and α's are, therefore, set to zero at the start. Changes in y_i, in turn, affect other endogenous variables. Mathematically, we say that the y's are determined simultaneously. A model of m endogenous variables and k exogenous variables may be written generally as

$$\begin{aligned}
y_1 &= \alpha_{12} y_2 + \alpha_{13} y_3 + \ldots + \alpha_{1m} y_m + \beta_{10} + \beta_{11} x_1 + \ldots + \beta_{1k} x_k + \epsilon_1 \\
y_2 &= \alpha_{21} y_1 + \alpha_{23} y_3 + \ldots + \alpha_{2m} y_m + \beta_{20} + \beta_{21} x_1 + \ldots + \beta_{2k} x_k + \epsilon_2 \\
&\vdots \\
y_m &= \alpha_{m1} y_1 + \alpha_{m2} y_2 + \alpha_{m3} y_3 + \ldots + \beta_{m0} + \beta_{m1} x_1 + \ldots + \beta_{mk} x_k + \epsilon_m
\end{aligned}$$

As just indicated some β's and α's are set to zero as part of the model specification.[2] Others are to be estimated statistically from data generated by the economy through time.

Given a body of data the nonzero parameters in the model can be estimated by one of several estimation procedures. The estimated model is referred to as a structure. As mentioned, it can be used to forecast the course of the economy and to evaluate the effectiveness of economic policy. To see how this is done, we first rearrange the system of estimated relations, taking all the endogenous variables to the left hand side of the equations:

$$y_1 - a_{12}\, y_2 - \ldots - a_{1m}\, y_m = b_{10} + b_{11}\, z_1 + \ldots + b_{1k}\, z_k + \epsilon_1$$

$$-a_{21}\, y_1 + y_2 - \ldots - a_{2m}\, y_m = b_{20} + b_{21}\, z_1 + \ldots + b_{2k}\, z_k + \epsilon_2$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$-a_{m1}\, y_1 - a_{m2}\, y_2 - \ldots + y_m = b_{m0} + b_{m1}\, z_1 + \ldots + b_{mk}\, z_k + \epsilon_m$$

where b's and c's are respectively the estimated values for α's and β's. The ϵ's are residuals. Employing matrix notation and ignoring the residuals, the system can be written as

$$C\, y = B\, z,$$

where y and z are vectors of the endogenous and predetermined variables, and C and B are matrices of coefficients. The endogenous variables can then be solved in terms of the predetermined variables as

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[2]The model specification also includes an assumption about the distribution function of the disturbances. Such statistical specification, as well as similar technical details, will not be discussed in this paper.

$$y = C^{-1} B z = P z.$$

This relation enables us to identify the values of the endogenous variables for given values of the exogenous factors. Some exogenous variables behave in a predictable fashion; others are policy variables subject directly to the manipulation of the policy makers. Both of these can be predicted by the policy makers with precision. Others can only be predicted with some margin of error. But since they vary independently of the model, their prediction is a separate problem. Conceptually, therefore, we can treat the future values of z as given. The model can then be used to forecast the values of y. Secondly, included among the predetermined variables are some policy variables. Effects of changes in these policies on the endogenous economic activities can be inferred from the model. In other words, each number in the P matrix measures the total effect--both direct and indirect--of a unit change in an exogenous variable on an endogenous variable.[3] Thus, the model can be used for policy valuation. Thirdly, the model can be used for policy recommendation. In this application, a set of objectives or targets is predetermined in terms of values of y. A set of policy variables is also selected from z. The systems can then be solved for alternative combinations of values that these variables may take--policy packages--to achieve the desired values for y.

Characteristics of the Hawaiian Economy Reflected in the Model Structure

The model that we formulated for the Hawaiian economy may be described

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[3] More specifically, elements of the jth column in P measure the effect of a unit change in the jth exogenous variable on various endogenous variables. In the literature, P matrix is also referred to as the matrix of multipliers.

in the above context. There are 30 endogenous variables in the model, determined by 25 behavioral or institutional equations and 5 identities.[4] They consist of 18 components of employment, 7 components of income, 3 components of housing demand, as well as value of retail sales and population age 14 or over. There are also 22 exogenous variables and 9 lagged endogenous variables. Conspicuously absent from the list of endogenous variables are investment in producers' durables and consumer expenditures. For most econometric models, economic activity is analyzed from the product side in terms of various kinds of expenditures. In our model, economic activity is analyzed from the income side in terms of payments to various factors of production. Wage income specifically is analyzed in great detail. This unorthodox strategy, necessitated by the availability of data,[5] will be justified in terms of the special nature of the Hawaiian economy.

The equations in our model are recursive. That is, they can be arranged in such a manner that in each equation the variables on the right hand side consist only of predetermined variables and endogenous variables that are explained by equations preceding it. Symbolically, the system can be written generally as

$$Y_1 = b_{11} X_1 + b_{12} X_2 + \ldots + b_{1k} X_k + \epsilon_1$$

$$Y_2 = a_{21} Y_1 + b_{21} X_1 + b_{22} X_2 + \ldots + b_{2k} X_k + \epsilon_2$$

$$Y_3 = a_{31} Y_1 + a_{32} Y_2 + b_{31} X_1 + b_{32} X_2 + \ldots + b_{3k} X_k + \epsilon_3$$

$$Y_4 = a_{41} Y_1 + a_{42} Y_2 + a_{43} Y_3 + b_{41} X_1 + b_{42} X_2 + \ldots + b_{4k} X_k + \epsilon_4$$

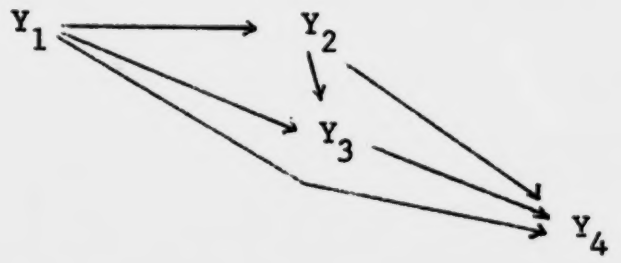
$$\ldots$$

---

[4] Identities are definitional relations among variables. They require no statistical estimation.

[5] Efforts to compile an income and expenditures account for Hawaii were first initiated in the earlier 60s by the Economic Research Center. Preliminary results are now available for the years 1958-64 [11; 15].

In theoretical terms, this means that the influences among the endogenous variables are always in one direction as shown in the following diagram.



As will be pointed out in Chapter II, this formulation which simplifies the estimation procedure conflicts with our general understanding that in the aggregate economic activities tend to be interdependent. Given the unique structure of the Hawaiian economy, however, our model is both relevant and realistic. Briefly, the Hawaiian economy differs from the national economy in the following important aspects:

(1) The economy is dominated by a small number of autonomous industries. Increasingly, residents of the State derive their income, directly or indirectly, from these industries: sugar-pineapple, tourism, or the federal government. The activity in all three is determined chiefly by external factors.

(2) The manufacturing sector, excluding sugar and pineapple, is quite small. Consequently, Hawaii imports most of its requirements for manufacturing products and a substantial portion of its foodstuff and raw materials. The prominence of the external and the public sectors is shown in Table 1.

TABLE 1

EXPENDITURES ON GROSS DOMESTIC PRODUCT
(In millions of dollars)

	1961	1962	1963	1964
Personal consumption expenditures	$1,142.7	$1,136.9	$1,221.8	$1,364.5
Adjustment for discrepancy	100.5	29.6	65.8	130.5
Commodities	700.9	746.6	785.2	850.1
Services	341.3	360.7	370.8	383.9
Gross private investment	288.5	318.4	302.9	350.3
Adjustment for discrepancy	25.4	8.3	16.3	33.5
Construction	186.6	239.9	191.2	214.8
Equipment	76.5	70.2	95.4	102.0
Changes in inventory	16.2	13.7	16.2	17.6
State and local government expenditures	230.4	266.7	314.4	325.4
Federal government expenditures	459.4	441.9	451.5	495.9
Export of goods and services	535.7	578.1	664.7	702.9
Less: Import of goods and services	796.3	805.1	865.6	978.0
Expenditures on gross domestic product	$1,876.6	$1,950.6	$2,105.9	$2,278.6

Source: Shang, et al., Hawaii's Income and Expenditures, 1961-64, with Certain Revisions of Previous Estimates, 1958-1960 (University of Hawaii, Economic Research Center, 1967), I-15.

Note that in 1964 export and import of goods and services amounted to 30 and 40 percent, respectively, of total GDP, and federal expenditures accounted for 21 percent.

(3) The economy tends to be more labor intensive. Compared with the nation as a whole, a considerably higher percentage of private employment is engaged in trade, services, and construction. This, of course, is the other side of the underdevelopment of the manufacturing sector as depicted in Table 2.

TABLE 2

DISTRIBUTION OF EMPLOYMENT IN THE PRIVATE SECTOR, FOR THE UNITED STATES AND HAWAII: 1964

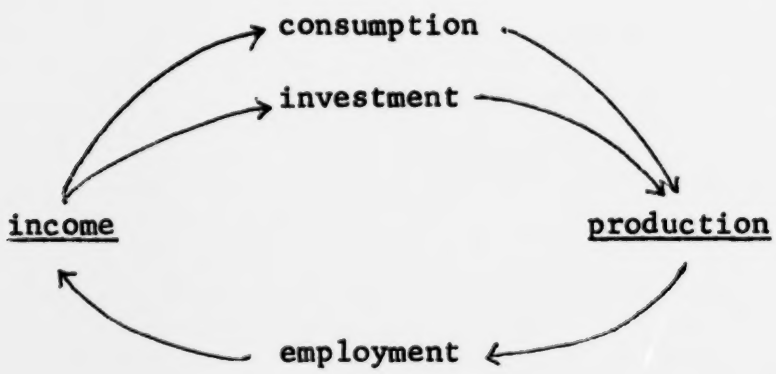
Industrial Component	Percent Distribution	
	Hawaii	United States
Total	100.0	100.0
Farms and mining	7.7	10.1
Contract construction	9.8	5.8
Manufacturing	15.2	32.4
Wholesale and retail trade	28.7	22.8
Finance, insurance and real estate	7.3	5.5
Transportation, communications and public utilities	9.4	7.4
Services	21.9	16.0

Source: Artle, R.A. and R.W. Rider, The Hawaiian Economy, Problems and Prospect (State of Hawaii, Department of Planning and Economic Development, 1966), Table 19.

Our focus on employment and labor income is, therefore, in consonance with the labor intensiveness of the Hawaiian economy. For example, in 1964 wage and salary income made up 76 percent of personal income in Hawaii, as compared with 68 percent for the nation as a whole.[6] More importantly, the special structure of the Island's economy justifies our somewhat unconventional approach of formulating our model from the income side rather than the expenditure side.

[6]U.S. Department of Commerce, Statistical Abstracts for the United States (1966), 328.

Generally, the demand oriented model of the national economy is built on the theoretical foundation of the Keynesian theory of income and employment. Income and employment are determined by effective demand which consists primarily of consumption and investment. The propensity to consume is pivotal to the whole system. And, given the propensity to consume, investment is the main propellant of the economy. Consequently, the determination of consumption and investment occupies rightfully the center of the stage. Diagramatically, this can best be described as a circular flow:



Various activities are certainly interdependent. And in a market-oriented economy, the key to understanding the system is through determination of the aggregate demand.

The Hawaiian economy, however, does not fit this framework very well. While it is still true that income is allocated between consumption and investment (abstracting other components), expenditures do not generate income and employment in the same way as in a national economy due to the very high propensity of import. It has been estimated that for each dollar spent in consumption, only 49 cents stays in the State.[7] A substantial part of

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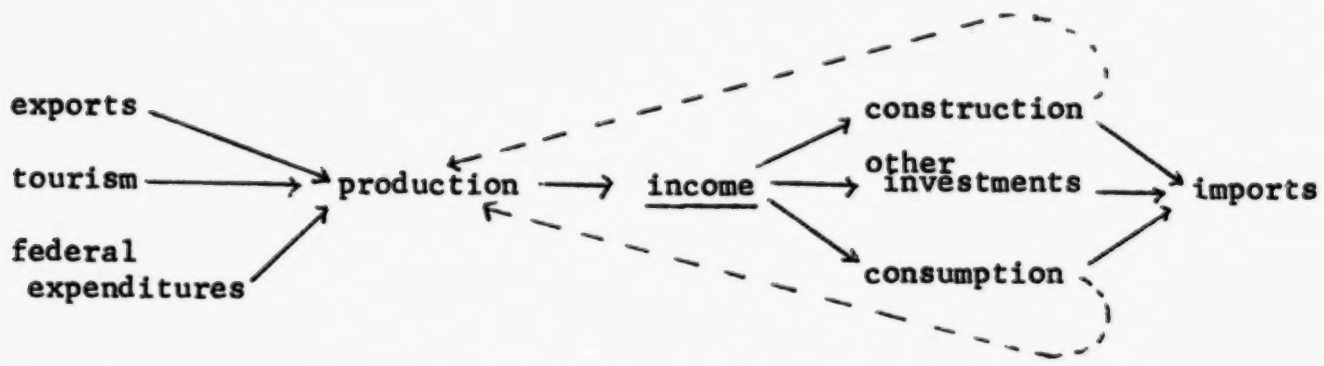
[7] First National Bank of Hawaii, Department of Economic Research, The Impact of Exports on Income in Hawaii, p. 19.

this probably represents local taxes, retail and wholesale margins, and services. The other 51 cents leaks out to pay for imports. The leakage associated with investment expenditures on producers' durables is probably at a much higher rate since there is practically no machine or tool-making industry on the Islands. Diagramatically, the system may be described as



Therefore, the level of allocation of employment need not follow closely the level and composition of "domestic" expenditures. Investment, in particular (aside from construction), has little immediate or secondary effect on employment. With the income creating effect of consumption and investment greatly dampened by the high propensity to import, the resulting relation approaches a one-way causation. This, we recall, is the basic assumption of a recursive type model. What we have drawn is, of course, a grossly oversimplified picture. More details will be filled in when we come to formulating the model in the next chapter.

CHAPTER II

THE MODEL

Variables

For the purpose of our discussion, we find it useful to make the following classification of variables:

explained variables (current endogenous variables)

predetermined variables

exogenous variables

lagged endogenous variables

input variables

Endogenous variables depict economic activities explained by the model. Exogenous variables are independent of endogenous variables. Lagged endogenous variables, being fait accompli, are clearly independent of the explained variables. Both are authentic predetermined variables. Input variables, on the other hand, are those which on theoretical ground are likely to be dependent on other endogenous variables. In our model, however, they are treated as predetermined variables for one or more of the following reasons:[8]

(1) The relation is too complicated to be delineated in a simple relation, or there is reason to believe that significant changes took place during the sampling period.

(2) Published information about their main determinants are not available.

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[8]Note: The input variables will be incorporated into the category of explained variables should the necessary information become available, or should the empirical results indicate such a need.

(3) Reliable forecasts have been furnished by informed sources.

Since the main objective of our model is to describe the determination of civilian personal income and employment, endogenous variables consist largely of their components. Of the 30 endogenous variables used, 7 refer to incomes: total personal income, proprietor income, property income, corporate profit, wage rate, wage income of the private sector, and transfer payments; 3 are expenditures: residential construction, commercial construction, and retail sales; 18 are related to employment: employments for 15 industries or industry groups, employment in the private sector, total employment, and unemployment; and the remaining 2: population age 14 or over and labor force.

The principal driving forces of the economy are commodity exports, tourist expenditures, and defense expenditures. Their activities are reflected in the following exogenous variables:

outputs of sugar and pineapple

value of other commodity exports

number of visitors, their total days of stay and expenditures,

stock of hotel rooms and their occupancy rate

government expenditures, employment, wages, and public construction

The following exogenous variables are introduced specifically to explain activity of the housing industry:

Aaa bond yield, FHA and VA ceiling interest rates, stock of housing.

Finally, the following components of income are exogenous:

Property income from investment overseas

Wage income from the public sector

Variables which may be expected to depend on other exogenous or endogenous factors but are treated here as predetermined for simplicity or for lack of data include:

income and employment of diversified agriculture

nonagricultural self-employed

population and immigration

consumer prices (cost of living index)

construction cost index

Income and employment from diversified agriculture constitute a case where all reasons for not considering them as endogenous are present. Diversified agriculture here consists of all agricultural products other than sugar and pineapple, as well as poultry, cattle, and, by extension, fisheries products. The large variety of crops is produced mainly by small scale operators.[9] Hence, there is a serious data problem. The demand and supply of this sector is complicated by such external factors as changing tastes, competition from imports, competition for use of land and labor from other rapidly expanding sectors, particularly the tourism industry. As a result, relations governing income and employment of this sector are likely to be complicated as well as unstable and cannot be introduced efficiently and easily in an aggregate model. However, a comprehensive study of this sector was completed recently by Professor Renaud of the Department of Agricultural Economics at the University of Hawaii and his results can be used to provide extraneous

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[9]Total value is small. In 1967 sales totaled $54.3 million, or 2.2 percent of the total personal income. (Bank of Hawaii, Annual Economic Review, 1968), p. 30, p. 40.

estimates on farm income and employment.[10]

The number of nonagricultural self-employed workers reported by the State Department of Labor and Industrial Relations was estimated, industry by industry, by multiplying a constant ratio to the number of existing employing units. The constant ratio is calculated as[11]

$$\frac{\text{number of self-employed workers in the April 1960 U.S. Census}}{\text{number of employing units in April 1960 in the State}}$$

It is dubious that this ratio should remain unchanged. Thus, our information on this variable may be subjected to large measurement error, and any relation estimated from it is questionable.

It can be argued that population growth for Hawaii should be considered endogenous. There has been a sizable net immigration into Hawaii in recent years. Presumably, immigration is responsive to economic opportunity. But data on immigration are fragmentary. Preliminary analysis failed to establish significant relation between net immigration and such economic indicators as income and employment. Population projections are published regularly by such national agencies as the Bureau of the Census, the National Planning Association, and the U.S. Department of Commerce. In Hawaii, the State Department of Planning and Economic Development publishes periodic reports on population projections for the State.

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[10] In that study [13] Professor Renaud estimated the demand and supply relations for each of 17 selected products. Domestic productions were projected to the year 1975.

[11] For a description of the method see: State of Hawaii, Department of Labor and Industrial Relations, Description of Method of Estimating Labor Force Data, January 1965, p. 2.

A complete listing of variables in our model appears in Tables 3 and 4 at the end of this chapter. Their observed values for the period under consideration and sources of information are found in Appendix A.

Structure

The present model portrays several aspects of the economy in highly aggregate terms. The interrelations among them, their relation to predetermined factors, and the emphasis each of them receives in the model are depicted in the following diagram. Exogenous variables are placed in circles, endogenous variables in rhombuses. A solid arrow indicates direction of influence, and a broken arrow indicates direction of aggregation. Variables are defined in Tables 3 and 4.

Income and employment in Hawaii originate from three well-defined sectors: export, domestic, and government. They are represented in the diagram by 3 boxes in the center. The export sector is made up primarily of visitor expenditures and exports of sugar and pineapple. They contribute directly to employment and profits of firms in this sector. Tourist expenditures also spill over to retail establishments of the domestic sector. The public sector of Hawaii is swelled by sizable defense-oriented federal expenditures. Military payroll, however, is not included in our model since a very small portion of this is spent locally.[12] The defense establishment employs approximately twenty thousand civilian employees whose income, as

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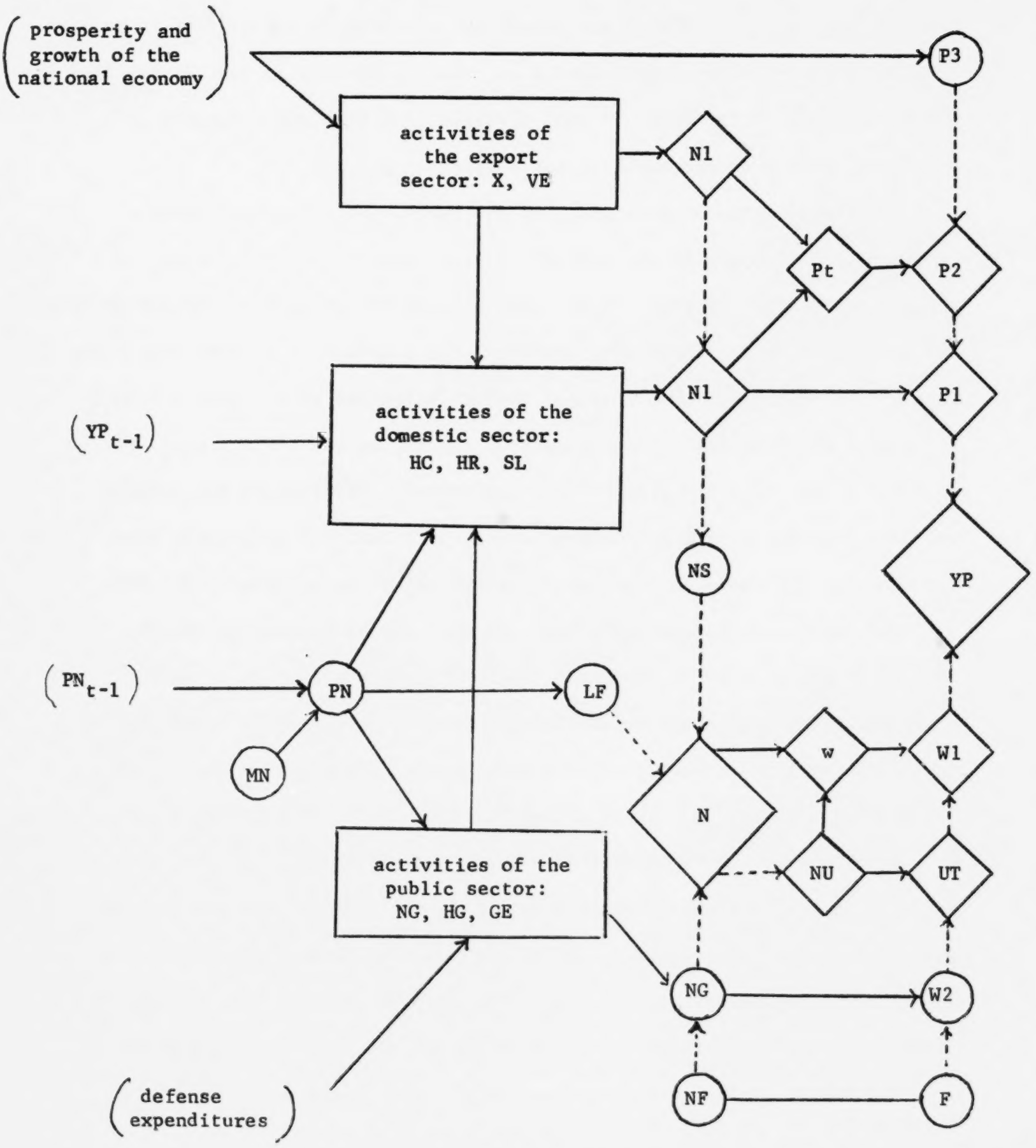
[12]This is due to the existence of military retail outlets which import directly from the mainland, free supply of certain goods and services by the government, and remittance of earnings to dependents on the mainland. See Yuan-Li Wu, Fluctuations in Defense Spending and Their Economic Impact on Hawaii (Economic Research Center, University of Hawaii, 1965), p. 33.



FLOW CHART OF THE MODEL

well as construction and other direct purchases, promote activities of the domestic sector. Non-defense employment and procurement are undertaken by federal, state, and local governments in order to provide various kinds of public services. The demand of such services is determined primarily by population, which is exogenous in our model.

Activities in both the export and the public sectors are considered exogenous. The growth of the domestic sector, however, relies heavily on expansions in other sectors. Since Hawaii imports most of its consumer goods and all of its investment goods, resources for growth have to come from earnings of the export sector or capital inflows attracted by prospects of such earnings. The domestic sector is made up largely of the trade (retail and wholesale), service, and construction industries. Diversified agriculture and manufacturing catering to domestic needs are still of relatively minor importance. And there is practically no manufacturing of producers' goods.

The relations between employment, income, and activities in various sectors of the economy as described in the diagram are formulated into 25 structural equations and 6 definitional equations. Of course, the structure chosen is one of many that can conceivably be formulated to represent the system. It reflects to a large extent our preference for simplicity and for using only readily available data. For behavioral equations, we give only the variables involved; functional forms are to be determined from empirical results. The equations define the relation between annual flows of expenditure, employment, and income. They are divided into four groups: determination of proprietor and property income, determination of private wage and salary employment, determination of wage income, and identities.

The subscript "-1" indicates that the variable is lagged one year, and the symbol "Δ" stands for first difference. Exogenous variables are underlined.

Proprietor and property incomes are determined by the levels of business activities. Activity of the export sector is represented by total commodity exports and total visitor expenditures, both of them considered given to the system, as is value of public construction. Activity of the domestic sector is represented by construction and retail sale. They are endogenous, and their determinations are specified in the first three equations.

Three categories of construction are distinguished: public, residential, and commercial (D.1). In equation (1) we hypothesize that the demand for new residential units is governed by three major factors: need, income, and the availability and cost of credit. Need is indicated by growth of population. The availability of credit is determined by the competitiveness of the mortgage market, indicated here by the interest differential between FHA and VA ceiling interest rates and Aaa bond yield.[13] In addition to regulating the flow of FHA and VA financed construction, FHA and VA ceiling interest rates may be considered by homebuilders as a sort of normal price for mortgage loans. The interest rates on mortgages may be expected to move up and down with bond yields, so the variable used in the equation also measures the difference between actual and "normal" cost of credit to homebuilders. Since the decision to build a new house takes time and there is also a considerable gestation period between that decision and actual

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[13]This variable was used by Suits in his national econometric model to determine housing start. See D.B. Suits, "Forecasting and Analysis with an Econometric Model," (American Economic Review, March 1962), p. 114.

construction, we decided that last year's income may be a more relevant determining factor than current income. For the determination of commercial construction (2), we use both last year's hotel occupancy rate which indicates the demand for new hotels and lagged profits of proprietors and corporations which indicate both the need and the availability of funds for new construction.

To a large extent, retail sales (SL) represent consumer expenditures on commodities. As such, personal income is the most relevant determinant. But for statistical reasons, we prefer not to use any endogenous variable as regressor. We envisage three kinds of commodities traded over the retail counter: necessities, consumer durables, and convenient-luxurious goods. Inasmuch as the demand for necessities in an affluent society is inelastic to income, past income is a good indicator of their demand. The demand for such durables as home appliances and furniture may be expected to follow the completion of new housing units. Residential construction also indicates general affluence and can serve as a proxy for demand factors of discretionary consumption and luxuries. Given the structure of equation (1), the effect of population change can also be accounted for by residential construction. A portion of visitor and government expenditures is spent at retail outlets. The variables chosen in equation (3) to determine retail sales, therefore, are lagged income, residential construction, visitor and government expenditures. A notable omission in our presentation of the domestic sector is sales by service industries. This is due to the lack of data.

Proprietor income (P1) measures the earnings of noncorporate businesses and professionals. Such earnings originate predominantly from retail sales

and sales of services. Therefore, in equation (4) proprietor income is explained by retail sales and population. Since an upward shift has been observed in the demand for services in this country, a trend variable (t) is also introduced. Corporate businesses operate in both the export and the domestic sectors, so in equation (5) corporate profit (Pt) depends on all three major components of final demand thus far considered: exports, retail sales, and construction.

Property income (P2) comprises of dividends, personal rental income and personal interest income. Interest and rental incomes are bound to a large extent by contracts, and corporations may be expected to maintain a stable rate of return to their shareholders. Consequently, property income tends to be much more stable than proprietor income. Therefore, we choose to explain the annual increment of property income in equation (6). This increment is hypothesized to depend on changes in corporate profits and residential construction of the previous year. Since the relation is estimated by its first difference, a trend relation is implied. Given this annual increment, property income is obtained in (6a) as a simple identity.

Wage and salary workers of the private sector (N1) are classified into 15 categories, following the general line of classification used by the State Department of Labor and Industrial Relations in reporting employment.[14] Of these, 4 are related to the export sector, 3 to construction and manufacturing, 3 to trade, 4 to services and utilities, and 1 nonclassified. In

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[14]State of Hawaii, Department of Labor and Industrial Relations, Employment and Payrolls in Hawaii (annual).

general, when data on output are available, employment is determined as a function of real output and a time trend. The time trend is introduced to measure growth of labor productivity and is expected to have a negative coefficient reflecting decreases in the relevant employment/output ratio. This is the case for the following industries: sugar (7), pineapple (8), hotel (9), contract construction (12), construction materials (13), and retail (16). In cases where information on output is not available or outputs included are too heterogenous to be represented by a single value, factors determining the demand for such outputs are used as explanatory variables. Thus population is used to explain employment in diversified manufacturing (14) and public utilities (19) while population and visitors are used to explain employment in recreational establishments (11) and transportation (18).

Information on output of the garment industry is fragmentary. It has been estimated that from 45 percent to 70 percent of the total sales of the industry were made overseas while 60 percent of the local market was purchased by tourists.[15] Since the Hawaiian garment is still a relatively new product on mainland markets, some sort of learning process is relevant for the development of its demand. In this case, current sale will depend on lagged sales. Therefore, in equation (10) employment in the garment industry is made a function of lagged employment and the total number of days that visitors spend in Hawaii.

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[15]E.L. Fundaburk, The Garment Manufacturing Industry of Hawaii (University of Hawaii, Economic Research Center, 1965), p. 44, p. 77.

Wholesale establishments replenish the stocks of retailers, supply raw materials and intermediate goods to manufacturers, sell building materials to contractors, and fill the orders for investment goods for all businesses. In equation (16) we explain employment in wholesale trade and trucking-warehousing as a function of retail sales and construction. Construction may also be expected to pick up the effect of business investment since the two are closely related.

For employment in finance, insurance, and real estate (17), total retail and wholesale employment is used to indicate the size of the business community served by the financial sector while construction indicates the need for real estate services. Since employment in hotel and entertainment industries have already been accounted for, the rest of the service industries primarily serve the resident population. As the portion spent on services tends to increase with personal income, a trend variable is also included in equation (20). Finally, unclassified employment is determined simply as proportionate to the sum of other private employments (21). Total wage and salary employment is defined as the sum of these 15 categories of employment (D.2).

The next step is to estimate the determination of wage rate in the private sector, which in turn depends on the rate of unemployment. By now we have determined total employment in the private sector. Civilian employment of the public sector (NG) is classified into three categories: defense-related federal employment, other federal employment, and state and local government employment (D.3). They are all exogenous. Employment in diversified agriculture (NF) and nonfarm self-employed (NS) are also determined extraneously. Together they constitute total civilian employment (D.4).

Unemployment then is the difference between labor force (LF) and this total employment (D.5). The base of our labor force is civilian population age 14 and over. Each year the number of this age group is increased by the number of 13-year-olds a year before minus the number of deaths among the 14 and above over the past year, and net immigration (22), (22a).[16] A labor force participation rate, together with a trend, determines the labor force (23). The percentage change in average wage rates of the private sector is then determined as a function of the unemployment rate and change in the cost of living index (24). This is a version of the familiar "Phillips curve" which is widely used in empirical studies.[17] Having determined both employment and wage rate, the calculation of wage income from the private sector is an easy matter (24a). Since transfer payments consist primarily of unemployment compensation and retirement benefits they are determined in equation (25) by the number of unemployed and the size of population age 65 and over.

Four components of personal income are determined from the system: wage income of the private sector, proprietor income, property income, and transfer payments. Together they account for about 75 percent of total civilian personal income in recent years. The remaining exogenous components are wage income from the public sector, farm income from diversified agriculture, and property income from overseas investment of residents of the State. This relation is defined in (D.6).

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[16]The relation is used in the Michigan model. See D.B. Suits, Econometric Model of Michigan (Michigan Department of Commerce, State Resource Planning Program, April 1966), p. 23.

[17]A.W. Phillips, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," Economica, 25 (1958), pp. 283-299.

The model just considered is of the recursive type: the structural equations are arranged in such a manner that the endogenous variable explained in each equation depends only on predetermined variables and endogenous variables that have been explained in preceding equations. This greatly simplifies the estimation procedure as unbiased estimates of the recursive-form parameters can be obtained by applying classical least squares method to each equation.[18] Such simplification is important in this case since the small size of our sample[19] greatly limits the use of any simultaneous estimation procedure. For the same reason of data limitation, a small number of explanatory variables, usually two, are used in each equation. As a result, there may be specification error in some relations which under certain circumstances can bias our estimates of the parameters. This will be taken into consideration when we discuss results of the estimation in the following chapter.

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[18]Provided also the disturbances of the structural equations are uncorrelated. See A.S. Goldberger, Econometric Theory (New York: John Wiley and Sons, 1964), pp. 382-83.

[19]Our sample period covers 1951 to 1968.

STRUCTURAL EQUATIONS

Determination of Proprietor and Property Incomes

(1) $HR = f(\Delta\underline{PN}, YP_{-1}, [\underline{FHA} + \underline{VA}]/2 - Aaa)$

(2) $HC = f(OR_{-1}, P1_{-1}, Pt_{-1})$

(3) $SL = f(YP_{-1}, HR, \underline{VE}, \underline{GE})$

(4) $P1 = f(\underline{PN}, SL, t)$

(5) $PT = f(\underline{X}, H, SL)$

(6) $\Delta P2 = f(\Delta Pt, HR_{-1})$

(6a) $P2 = P2_{-1} + \Delta P2$

Determination of Employment

(7) $n1 = f(\underline{Qs}, t)$

(8) $n2 = f(\underline{Qp}, t)$

(9) $n3 = f(\underline{RN}, \underline{OR}, t)$

(10) $n4 = f(\underline{n4_{-1}}, \underline{VD})$

(11) $n5 = f(\underline{PN}, \underline{VD})$

(12) $n6 = f(H, t)$

(13) $n7 = f(H, t)$

(14) $n8 = f(\underline{PN}, t)$

(15) $n9 = f(SL)$

(16) $n10 = f(SL, H)$

(17) $n11 = f(n8 + n10, H, t)$

(18) $n12 = f(\underline{PN}, \underline{V})$

(19) $n13 = f(\underline{PN})$

(20) $n14 = f(\underline{PN}, t)$

(21) $n15 = \rho(n1 + n2 + \ldots n15)$

Labor Force and Wage Rate

(22) $\Delta PN14 = f\ (PN(13)_{-1},\ PN14_{-1},\ MN)$

(22a) $PN14 = PN14\ (t-1) + \Delta PN$

(23) $LF = f\ (t,\ PN14)$

(24) $\Delta w1 \Big/ w1_{-1} = f\ (\frac{NU}{LF},\ \Delta p_{-1})$

(24a) $W1 = w1 * N1$

(25) $UT = f\ (\underline{PN65},\ NU)$

IDENTITIES

(D.1) $H = HR + HC + HG$

(D.2) $N1 = n1 + n2 + \ldots\ n15$

(D.3) $NG = NG_d + NG_f + NG_s$

(D.4) $N = N1 + NG + NF + NS$

(D.5) $NU = LF - N$

(D.6) $YP = W1 + P1 + P2 + UT + P3 + W2 + F$

TABLE 3

DEFINITION OF VARIABLES: PREDETERMINED VARIABLES

Variables	Definition
Aaa	Aaa bond yield
F	Nonfarm proprietors' income
FHA	Maximum permissible interest rate on FHA-insured mortgage loans
VA	Maximum permissible interest rate on VA-guaranteed mortgage loans
GE	Government expenditures on goods and services
HG	Public construction put in place
MN	Net immigration
NF	Employment in diversified agriculture
NG	Government civilian employment
NG_d	Defense-related federal civilian employment
NG_f	Other federal civilian employment
NG_s	State and local government employment
NS	Nonagricultural self-employed
OR	Average hotel occupancy rate
P3	Property income from overseas investment
PN	Resident civilian population
PN(13)	Number of 13-year olds in the civilian population
PN65	Civilian population age 65 or over
Q_p	Real output of pineapple
Q_s	Real output of sugar

TABLE 3 -- continued

Variables	Definition
RN	Total number of hotel rooms on July 1
t	Time trend (1951 = 1)
V	Number of overnight visitors
VD	Number of visitor days
VE	Visitor expenditures
W2	Wage income from the public sector
X	Value of commodity exports
p1	Cost of living index
p2	Construction cost index

TABLE 4

DEFINITION OF VARIABLES: ENDOGENOUS VARIABLES

Variables	Definition
H	Construction put in place
HC	Commercial construction put in place
HR	Residential construction put in place
LF	Civilian labor force
N	Total employment
NU	Unemployment
N1	Wage and salary workers of the private sector
n1	Employment of the sugar industry
n2	Employment of the pineapple industry
n3	Employment in hotels and rooming houses
n4	Employment in the garment industry
n5	Employment in movie houses and other recreation services
n6	Employment in contract construction
n7	Employment in construction-related manufacturing (lumber and wood products, furniture and fixtures, stone, glass and clay)
n8	Employment in food processing, printing-publishing, and miscellaneous manufacturing
n9	Employment in retail establishments
n10	Employment in wholesale trade, trucking, and warehousing
n11	Employment in finance, insurance, and real estate
n12	Employment of the transportation industry (other than trucking and warehousing)

TABLE 4 -- continued

Variables	Definition
n13	Employment by communications and other utilities
n14	Employment in services (other than hotels and recreational establishments)
n15	Nonclassified employment
PN14	Civilian population age 14 or over
Pt	Corporate profit
P1	Nonfarm proprietors' income
P2	Property income earned by Hawaii residents from investment in Hawaii
SL	Retail sales
UT	Transfer payments
W1	Wage income from the private sector
w1	Average annual wage of the private sector
YP	Personal income

CHAPTER III

ESTIMATION OF THE MODEL

Data and Methods of Estimation

Structural equations of the models were estimated with annual time series data for the period 1951 to 1965. In a few cases where data were not available for the early years, more recent observations were also included in the estimation. Observations on variables used and their sources are presented in Appendix A. For each equation both the linear form and the logarithmic form were tried, and the form that yielded better results in terms of the following criteria was chosen:

(1) explanatory power

(2) precision of parameter estimates and the absence of autocorrelation

(3) plausibility of coefficient estimates

A coefficient of determination in terms of natural number of the dependent variable was calculated for each fitted relation as index of its explanatory power. In other words, the effect due to transformation of variables has been allowed for in comparing the explanatory power of alternative formulations.[20] Precision of coefficient estimate is indicated by the conventional t-ratio. Autocorrelation is tested by the Durbin-Watson statistic. Plausibility refers to the sign and magnitude of coefficient estimates. Whenever

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[20]For example, when the logarithmic value of the dependent variable (say Y) is used as regressand, the conventional R^2 measures the percentage of the variation of log Y that has been explained, whereas the R^2 of a linear relation measures the percentage of the variation of Y that has been explained. The two are not directly comparable. See A.S. Goldberger (1964), Econometric Theory, p. 217.

a coefficient is estimated with a wrong sign, the original structural relation is modified.

Numerical results for the "best performing" relation of the structural equations are presented and discussed below. The relations are estimated by single equation least squares method.[21] Presented for each regression are coefficient estimates, with their standard errors placed in parentheses, and the following statistics:

R^2 = coefficient of determination in terms of natural number of the dependent variable, followed in parentheses by the coefficient adjusted for degree of freedom

s = standard error of estimate, also in natural number

D-W = Durbin-Watson statistic

$\bar{y}$ = sample mean of the dependent variable

Since most relations are estimated with 15 observations and two regressors, a coefficient estimate is significant at the 5 percent level when it is 2.2 times its standard error or larger. However, since our main objective is forecasting rather than testing hypotheses, a regression coefficient is retained as long as it exceeds its standard error.[22] Results of the Durbin-Watson tests[23] are mentioned only when the statistic indicates the presence

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[21] Computations are performed using the "BMD03R" program of the Health Sciences Computing Facility, School of Medicine, UCLA (revised October 1968). A supplementary program is used to compute the Durbin-Watson statistic and to convert estimates of log formulation into natural numbers.

[22] This amounts to minimizing the estimated variance of the projection. See H.S. Houthakker and L.D. Taylor (1966), Consumer Demand in the United States, 1929-1970, p. 7.

[23] In making this test, the results developed by Theil and Nagar [18] are also used.

of serial correlation or when the evidence is inconclusive. In the former case, the relation will be reestimated by an iterative procedure.

In most cases, the estimated relation of the original formulation is acceptable on both statistical and theoretical grounds. In two or three cases, however, several alternative functional forms are tried before an acceptable one is discovered. These results should be accepted with reservation since they represent the outcome of curve fitting more than of testing preconceived hypotheses. Such a situation is marked by a "*" to indicate that that result should be reevaluated as soon as other sources of data are available.

Empirical Results

Determination of Proprietor and Property Income

Due to data limitation we depart from the structure specified above in several cases. Separate information for construction put in place for the three categories specified in our model is not available. However, permit values for the two categories of private construction (residential and commercial) have been reported since 1958. Consequently, equations (1) and (2) were estimated in terms of permit values for the years 1958-67.[24] Information on corporate profit was available only for 1958-64. In view of the simple corporate tax structure of the State, we may expect a simple proportional relation to hold between corporate net income and corporate tax collections.[25]

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[24] 1968 is not included. Permit value was unusually high for that year primarily due to the rush to secure permits prior to the effective date of the new Comprehensive Zoning Code for Honolulu on January 2, 1969.

[25] Corporate net income is taxed at only two rates, 5.85 and 6.43 percent. About 88 percent of the corporate tax revenue was collected at the higher rate.

Corporate tax collection was, therefore, employed as an instrumental variable for corporate profit in equation (5), where it appears as regressand, and in equations (2) and (6), where it appears as regressors. Since profits per se do not enter into personal income, the approximation does not necessitate any further adjustment to the model.

Variables in this section are measured in units of millions of current dollars unless otherwise noted.

(1) Residential construction

$$\log HR = \underset{}{-2.306} + \underset{(.330)}{.3786} \log (\Delta PN)_{-1} + \underset{(.312)}{1.226} \log YP_{-1}$$

$R^2 = .7107$ $(.6281)$ $\quad s = 20.1 \quad \bar{y} = 107.8 \quad$ D-W = 2.213

For lack of information the relation was estimated with only 10 observations (1958-1967). In estimating the originally formulated equation, the estimated coefficient for the interest rate variable came out with the expected sign but was smaller than its standard error, while the effect of population change was both small and negative. Since demand for new housing may respond to population change with a lag, the relation was reestimated with change in population lagged one period $(\Delta PN)_{-1}$. The interest rate coefficient remained small relative to its standard error so the variable was deleted. Coefficient estimates are very reasonable. They indicate that housing demand is elastic to income (income elasticity = 1.226), which is in general agreement with results of other empirical studies. The response to population growth is less than unity. This is typical of housing demand as the adjustment takes

a number of years to complete.[26]

(2) Commercial construction

$$HC = -104.2 + \underset{(.567)}{.8629}\ OR_{-1} + \underset{(.320)}{.3597}\ Pl_{-1} + \underset{(4.62)}{8.856}\ Pt^{*}_{-1}$$

$R^2 = .8932\ (.8398)$ $\quad s = .8248$ $\quad \bar{y} = 63.40$ $\quad D\text{-}W = 2.60$

The hypothesized relation for commercial construction is supported by the data. Of particular interest is the hotel occupancy rate variable (OR) since it is unique to Hawaii. Our estimated relation indicates that the increase of occupancy rate by one percentage point will generate about a million dollar's worth of commercial construction in the following year. Pt^{*} is corporate tax collection, which is about 6.3 percent of corporate profit. The estimated coefficient in terms of corporate profit is about .5, which is on a par with that estimated for proprietors' income. Both magnitudes are quite plausible. There were two downturns in commercial construction during the estimated period--in 1961 and 1963--and both are accounted for by the estimated relation.

(3) Retail sales

$$\log SL = 1.672 + \underset{(.043)}{.0947}\ \log HR + \underset{(.079)}{.2409}\ \log VE + \underset{(.150)}{.1942}\ \log YP_{-1}$$

$R^2 = .9919\ (.9884)$ $\quad s = 24$ $\quad \bar{y} = 1024$ $\quad D\text{-}W = 1.60$

Retail sales for 1957-67 are well explained by the postulated relation,

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[26]The relation will be undefined when population change in the previous year is negative. Should such a situation be envisioned in making forecasts, the following linear version can be used:

$$HR = -69.34 + \underset{(1.96)}{2.543}\ (\Delta PN)_{-1} + \underset{(.024)}{.0926}\ YP_{-1}$$

both in its logarithmic and its linear form.[27] The standard error is only 2 percent of the mean value of the dependent variable. Coefficient estimates are also reasonable. In recent years total visitor expenditures were about 28 percent of retail sales, so an elasticity of .24 is plausible. The income (lagged) elasticity of .2 may appear to be too low, but the variable was intended as an indicator for the demand of necessities while the demand for discretionary consumer goods is to be associated with residential construction.

(4) Nonfarm proprietors' income

$$P1 = -43.39 + .1541\ PN + .0622\ SL$$
$$\qquad\qquad\quad (.097) \qquad (.031)$$

$R^2 = .9812\ (.9771) \qquad s = 3.39 \qquad \bar{y} = 98.8 \qquad D\text{-}W = 1.38$

The proprietor income equation is estimated without the trend variable as originally formulated. Since there is almost perfect correlation between time and population in our sample, the taste effect associated with time would have to be picked up by the population variable. The relation was estimated for 1954-65 because information on nonfarm proprietor income is not available for earlier years. Coefficient estimates are reasonable. Six percent is a realistic retail margin. The population coefficient indicates that each additional person contributed $154 to proprietors other than those engaged in trade of diversified manufacturing producing for the home market. It represents a plausible amount spent on medical and other personal services.

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[27] Since there was almost perfect correlation (.9928) between lagged income and government expenditures in our data, the latter was dropped.

(5) Corporate profit

$$Pt^{*} = .4683 + .0187\ H + .0079\ X$$
$$\qquad\qquad\quad (.003) \qquad (.0088)$$

$R^2 = .9088\ (.8936)$ $\qquad s = .651$ $\qquad \bar{y} = 6.141$ $\qquad$ D-W = 1.634

Since information on corporate profit is not available, corporate tax collections are used as proxies. This may have contributed to the larger standard error of estimates. Values of retail sales and values of construction completed are highly correlated in our sample so only the latter is retained. The coefficient estimate for export is slightly smaller than its standard error. Nevertheless, as this is the only place where the value of export appears directly in the model, the variable is retained. Coefficient estimates are reasonable. If we inflate the regression coefficients by a factor of 16 to account for the fact that profit is about 16 times that of profit tax, the regression coefficient estimated for exports will be .126, a plausible profit margin. The coefficient for construction will be .299, not unreasonable if we remember that this coefficient also picks up the effect of retail sales, which correlates positively with construction.

(6)* Property income

Estimation of the property income equation as formulated in the model did not produce meaningful results. Coefficient estimates were unacceptable on theoretical or statistical ground. And the overall explanatory power of the regression was low. Several factors may have contributed to this failure.

(1) Variations in corporate profit may not be adequately represented by the variations of corporate tax liability.

(2) We have too few observations. The relation was estimated for 1958-68, years for which information on residential construction is available.

(3) The three components of property income, namely, dividends, personal rental income, and personal interest income may respond differently to the independent variables (in terms of time lags, symmetry with respect to positive and negative changes, etc.) so that a single relationship for their determination is not appropriate.

A promising alternative, therefore, is to analyze separately the three components of property income. But information on them is not available at present. However, we found that property income was well explained by the total number of residential housing units in the following relation:

$$P2 = -164.3 + 1.978\ HN \qquad (.083)$$

$R^2 = .9776\ (.9759) \qquad s = 7.07 \qquad \bar{y} = 114.5 \qquad D\text{-}W = 1.10$

The relation was estimated for 1951-65. HN is the number of private residential housing units on April 1 (measured in thousand units). In our sample the number of residential housing units is highly correlated with total visitor expenditures (correlation coefficient is .9834 for 1951-65 and .9912 for 1958-68). A high correlation between this number and other major contributors to corporate profit such as population and retail sales is also to be expected. This variable may actually serve as a conglomerate of factors relating to property income. At any rate, the relation fitted

performs well both in explaining sample variations of property income and in predicting property income for 1966-68.

Determination of Employment

Except where indicated, the employment relations for the 14 industrial groups are estimated for 1951-65. Employment is measured in persons, population is measured in thousands, and sales are measured in millions of constant dollars. Time (t) is measured with 1951 = 1.

(7) Sugar industry

$$\log n1 = 2.321 + \underset{(.099)}{.6881} \log Q_s - \underset{(.001)}{.0231}\, t$$

$R^2 = .9762\ (.9722)$ $\quad s = 665$ $\quad \bar{y} = 16889$ $\quad D\text{-}W = 1.431$

The industry is characterized by relatively stable output and falling employment. Between 1951 and 1965, total output (measured here in 1,000 tons of raw sugar) went up only 25 percent while employment decreased by about half. The falling rate of employment is reflected in the negative coefficient estimated for t which indicates that employment (given output) is falling at the compounded rate of 5.4 percent per year.[28]

(8) Pineapple industry

$$\log n2 = 3.407 + \underset{(.152)}{.3360} \log Q_p - \underset{(.001)}{.0072}\, t$$

$R^2 = .8509\ (.8260)$ $\quad s = 355$ $\quad \bar{y} = 10330$ $\quad D\text{-}W = 2.21$

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[28]Abstracting the output term, the structural form underlying the estimated equation is: $n1_t = n1_0\ (1+r)^t$, where $n1_0$ is the initial employment. The rate of growth (r) is related to the estimated trend coefficient, say b, as follows: r = antilog (b) - 1.

Like the sugar industry, the pineapple industry in Hawaii has had a stable output and declining employment during the period under consideration. Between 1951 and 1965, output showed little change while employment went down 15 percent. The employment figures used are the number of "Full-time Equivalent Employees" reported by the Pineapple Growers' Association. Information on output of fresh pineapple is available only in recent years. Previously, production was reported in terms of cases of canned juices and cases of canned pineapples. We have used the value of pineapple production deflated by a price index of canned pineapple as a proxy for real output. The fitted relation does not explain the data as well as the case with the sugar industry. The small variation in output may have caused this. The coefficient estimated for the trend variable indicates that after allowance has been made for changes in output, employment declines at the rate of 1.7 percent per year.

(9) Hotel and rooming houses

$$n3 = -1837 + .5568\ RN + 45.82\ OR - 196.3\ t$$
$$\qquad\qquad (.099) \qquad (18.9) \qquad (120)$$

$R^2 = .9806\ (.9754) \qquad s = 368 \qquad \bar{y} = 5175 \qquad D\text{-}W = 1.615$

As information on occupancy rate is not available for the years 1951 to 1953, the relation presented was estimated for 1954-1968.[29] In general, the estimated relation is in agreement with a priori expectation. It indicates

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[29]Employment is explained equally well by another plausible measure of output of the hotel industry, namely, the number of visitor days. But for forecasting purposes, the relation presented is preferable since the number of hotel rooms can be predicted with greater accuracy than the number of visitors and their average length of stay.

that an increment of two hotel rooms will add one employee to the hotel industry. The increase of one percentage point in the occupancy rate will add 45 new jobs. On the other hand, the labor requirement itself is declining through time as in the cases of the sugar and the pineapple industries.

(10) Garment industry

$$n4 = 286.8 + \underset{(.082)}{.8405}\ n4_{-1} + \underset{(.192)}{.3374}\ V$$

$R^2 = .9608$ (.9552) $\quad s = 127 \quad \bar{y} = 1796 \quad$ D-W = 1.345

Employment in the garment industry is reported by the State Department of Labor and Industrial Relations under "textile & apparel." However, it was estimated that in 1964 about 98 percent of this employment was engaged in making apparel, the rest in dyeing and finishing textile goods.[30] For our purposes, they may be considered as a single industry. The relation presented above is estimated for 1951-67 since the relation did not perform well when fitted to the 1951-65 data.

(11)* Employment in movie houses and other recreation services

$$\log n5 = -.842 + \underset{(.634)}{1.714}\ \log GNP(US) - \underset{(.014)}{.032}\ t$$

$R^2 = .6591$ (.6469) $\quad s = 154 \quad \bar{y} = 2945 \quad$ D-W = 1.345

Employment in recreation establishments was first estimated as a function of population and the volume of visitors to the State (VD). However, the coefficient for population was estimated with a wrong sign. Results from using visitor days and trend were also unsatisfactory. A cursory examination

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[30] Fundaburk, op. cit., p. 129.

of the data reveals that both the number of visitors to Hawaii and the population of Hawaii are highly correlated with the gross national product of the United States so the latter was chosen as an instrumental variable.

(12) Contract construction

$$n6 = 2836 + \underset{(6.21)}{83.46}\ H - \underset{(60.9)}{101.0}\ t$$

$R^2 = .9871\ (.9750)$ $\quad s = 401$ $\quad \bar{y} = 13150$ $\quad D\text{-}W = 3.01$

Between 1951 and 1965, the value of construction completed measured in real terms more than doubled. This rapid growth, as well as the increasing popularity of highrises, may entail technological changes in the industry. We would have liked to introduce the capital-labor ratio as an explanatory variable in the employment equation, but direct observation on capital is not available. Depreciation allowance, though, is reported by the State Department of Taxation and can serve as a proxy. However, 98 percent of the variation in employment is explained by the output variable and a time trend, and the estimated relation appears reasonable. We believe the results presented, therefore, are sufficient for making short run forecasts. Output is measured as the value of construction put in place deflated by an index of construction cost for Hawaii. The growth of labor productivity is reflected in the negative trend effect. The same conclusion is indicated by results of the logarithmic relation which also fits the data well. An elasticity of 0.82 was estimated.

(13) Lumber and wood products, furniture and fixture, stone, glass and clay

$$n7 = -587.5 + \underset{(3.10)}{14.23}\ H + \underset{(30.28)}{35.22}\ t$$

$R^2 = .9454\ (.9367)$ $\quad s = 200$ $\quad \bar{y} = 1590$ $\quad D\text{-}W = 1.50$

Output data for these industries are not available from published sources. Since demand for their products is closely related to new housing, we used the value of construction completed as a proxy. Employment is well explained by the fitted linear relationship. If we accept the trend effect as significant, it would indicate that employment in these industries grows faster than the demand for new housing. The same conclusion can be drawn from the estimated multilog relation where an elasticity of 1.33 is estimated for H and is highly significant. This may be caused by the substitution of domestic product for import.

(14a) Food processing and printing-publishing

$$n8a = -705.4 + 10.71\ PN \quad (.91)$$

$R^2 = .9140\ (.9080)$ $\quad s = 245$ $\quad \bar{y} = 5178$ $\quad D\text{-}W = 1.89$

When employment in the remaining diversified manufacture was analyzed in a single equation, as intended originally, the explanatory powers of the fitted regressions were relatively low. Closer examination of the data revealed that employments of the industries included in this group followed different trends in their variations. They should not be determined in a single relation. Among the industries included, food processing and printing-publishing are by far the largest, and their growth patterns were more systematic. Therefore, employment in these two industries was analyzed together. The trend variable in the original formulation has been deleted because its t-ratio was smaller than unity. Indeed, for the period under consideration, the employment population ratio was remarkably stable. For example, in 1965, 9.3 persons were engaged in these industries per thousand of resident population compared with 9.5 for 1951.

(14b) Miscellaneous manufacturing

$$\log n8b = -.2056 + 1.262 \log PN \quad (.249)$$

$R^2 = .7474$ (.7159) $\quad s = 133 \quad \bar{y} = 2110 \quad$ D-W = 1.199

This includes a hodgepodge of manufacturing of relatively minor importance: paper and allied products, leather and leather products, chemicals, fabricated metal products, machinery, transportation equipment, and an unidentified group. Together they account for only 1.4 percent of total civilian employment. All but a few of the producing units are small firms employing less than 20 persons.[31] They serve primarily local markets so population is the main determinant of demand. Understandably, total employment is very susceptible to random movements of individual components. Changes in employment as reported were especially erratic before 1958. Consequently, efforts to estimate a meaningful relation for the entire period of 1951-65 were not successful. The above relation estimated for 1958-67 is quite significant. It indicates that employment in these diversified industries has been growing faster than population, suggesting that the economy has diversified with the expansion of the home market.

(15) Retail trade

$$\log n9 = 3.458 + .2868 \log SL + .0159 t \quad (.222) \quad (.003)$$

$R^2 = .9866$ (.9843) $\quad s = 720 \quad \bar{y} = 27562 \quad$ D-W = 1.457

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[31] Hawaii State Planning Office (1960), "Manufacturing, Processing, and Construction," Economic Base Study of Hawaii, pp. 2-4.

Given the structure of the commodities sold at retail, the value added by the industry is approximately a fixed proportion of its sales. Thus, real sales may serve as a proxy for output. We found that trend variable added considerably to the explanatory power of the equation. The estimated coefficient indicates that employment is increasing at the rate of 3.4 percent per annum, after the effect of growth in sales has been accounted for. Some plausible explanations are:

a. substitution of salaried employees for self-employed
b. growth in the relative importance of sales of luxuries or other items which are labor intensive

The fact that the average number of employees of retail outfits rose from 7.2 to 12.3 persons between 1951 and 1965 is consistent with the first hypothesis. The rapid expansion of the tourist industry may have contributed to the second factor.

(16) Wholesale, trucking, and warehousing

$$\log n10 = 1.397 + \underset{(.047)}{.9133} \log SL$$

$R^2 = .9668$ (.9643) $\quad s = 367 \quad \bar{y} = 12471 \quad$ D-W = 2.014

Though we have strong reason to expect on a priori ground that activity of the housing industry would affect employment in wholesale, trucking, and warehousing, this conjecture is not supported by our empirical results. However, 97 percent of the variation in employment is explained by retail sales alone (measured in millions of dollars at constant prices). And all three downturns in employment during the sample period are registered by estimated value from the fitted relation.

(17) Finance, insurance, and real estate

$$\log n11 = \underset{}{-.1206\ E} \underset{(.533)}{.6929} \log (n9+n10) + \underset{(.103)}{.2816} \log H + \underset{(.008)}{.0210}\ t$$

$R^2 = .9935\ (.9917)$ $\quad s = 288$ $\quad \bar{y} = 7270$ $\quad D\text{-}W = 1.483$

Employment growth in this sector is explained extremely well by the logarithmic form of the hypothesized relation. With the linear relation, however, both the construction and the trend variables are not significant, and the standard error of estimate is almost twice as large. To the extent that the regressors used do approximate the volume of business handled, the result indicates that employment is not linear to output. In view of the nature of the business, this result is reasonable. The two regressor coefficients sum to approximately unity, thus employment in this sector is growing at the same rate as in trade and construction.

(18) Transportation

$$n12 = -6503 + \underset{(3.73)}{26.40}\ PN - \underset{(60.1)}{157.0}\ t$$

$R^2 = .9851\ (.9827)$ $\quad s = 161$ $\quad \bar{y} = 6740$ $\quad D\text{-}W = .940$

Transportation here includes bus lines, water transportation, air transportation, and transportation services. They all serve visitors as well as residents. However, as the growth in population and the growth in the number of visitors are highly correlated in our sample, it becomes difficult to allocate their relative contribution to the expansion of the transportation industry. When both variables were included in the regression, as intended in the model, the coefficient estimated for the number of visitors was

negative and statistically insignificant. Therefore, the functional form presented is adopted. Test of serial correlation on the basis of the D-W presented is inconclusive.

(19) Communication and utilities

$$n13 = -643 + 8.900\ PN \quad (1.17)$$

$R^2 = .9471\ (.9430)$ $\quad s = 157$ $\quad \bar{y} = 4232$ $\quad$ D-W = 1.112

Since the linear form and the logarithmic form of the relation perform about equally well in explanatory power as well as in other respects, we made our choice on the basis of their extra sample performances for predicting employments in 1966-68. In this case, the linear form is slightly better. Employment increased slightly faster than population, suggesting that the positive effect of income growth more than compensated for technological growth. Autocorrelation was detected in the residuals of the simple least squares estimation. The relation above was obtained by an iterative procedure designed to remove the autocorrelation in the disturbances.[32] The D-W statistic presented here is consistent with the absence of autocorrelation at the 1 percent level by the Theil-Nagar test.

(20) Employment in services other than recreation establishments

$$\log n14 = -.4658 + 1.721 \log PN \quad (.204)$$

$R^2 = .9381\ (.9334)$ $\quad s = 1207$ $\quad \bar{y} = 17470$ $\quad$ D-W = 1.21

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[32]The procedure is described in many standard texts of econometrics, e.g., Carl F. Christ, Econometric Models and Methods (New York: John Wiley and Sons, 1966), pp. 483-484.

Since employment in hotels and recreation establishments has been considered separately, services produced here cater predominantly to the needs of the resident population. The estimated relation indicates that the growth of service employment is almost twice as fast as that of the growth in population. An alternative formulation with employment as a linear function of population and a trend variable indicates that service employment increases at the rate of 500 per annum, after the effect of population has been accounted for. Like the employment equation for communication and utilities, this relation was also estimated by iteration.

(21) Unclassified employment

This is defined as the difference between total wage and salary workers in the private sector, as reported by the State Department of Labor and Industrial Relations, and total employment in all categories under n1 to n14. The latter is based primarily on the average monthly employment covered by Hawaii Employment Security Law and also reported by the State Department of Labor and Industrial Relations. The figure also represents the difference in coverage between the two series. It averaged 3461 over 1951-68, about 1.5 percent of total employment. The observations do not bear any discernible relation to total employment as intended in our model. Observations before 1960 are particularly erratic. After 1960, however, the number has been decreasing. Therefore, we estimated the following exponential trend relation for unclassified employment per thousand of total employment under n1 to n14.

$$\log (n15/ns) = 2.658 - .0958\ t \qquad (.010)$$

$$R^2 = .9597\ (.9539)$$

According to this relation estimated for 1960-68, the number is decreasing at the rate of 20 percent per annum.

Determination of Wage Income

Largely as a result of data deficiency, we have made some substantial changes in our estimated version of the relations determining labor force.

(22) Population age 14 and over

Estimation for equation (22) was complicated by the poor data on population by age groups.[33] For example, between April 1950 and July 1952, the data show a decrease of 52,000 for civilian population age 14 or over. But net outmigration of civilian population for the same period was only 32,000 and deaths 6,600.[34] Even if the 13-year-olds did not grow up, 13,000 persons are still to be accounted for. Therefore, the relation was estimated with the first two observations deleted. These estimated relations, however, were not meaningful with either the sign or the size of regression coefficients inconsistent with theory.

We note that our structural relation may be interpreted as coming from the following relation:

$$PN_{14} = (1-d')\ PN_{14}(t-1) + (1-d'')\ PN13(t-1) + \rho\ MN$$

where "d" denotes the mortality rate of a certain age cohort. In other words,

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[33] According to Mr. Robert C. Schmitt of the State Department of Planning and Economic Development, data on population by age groups for the 1950s are extremely dubious due to a questionable method for age allocation employed by the Bureau of the Census.

[34] The number of deaths is from the State of Hawaii, Department of Planning and Economic Development, Statistical Report 66 (April 30, 1969), p. 14. Other data and their sources are shown in Appendix A.

the 14-year-olds or over this year consists of the survivors of the 14-year-olds or over last year, the survivors of 13-year-olds last year, and the portion of net immigrants age 14 or over. Rearranging the terms yields the relation we estimate:

$$PN_{14} - PN_{14}(t-1) = - d'PN_{14}(t-1) + (1-d'')\ PN13(t-1) + \rho\ MN$$

Since the mortality rate of 13-year-olds may be expected to be closely approximated by that of the nation as a whole,[35] we may introduce the national mortality rate extraneously so as to reduce the number of parameters to be estimated from our sample. For 1959-61, the number of deaths per thousand of 13-year-olds in the United States was estimated to be .48, or d'' = .00048.[36] Therefore, we transformed our data and estimated the following relation:

$$\Delta PN_{14} - .99952\ PN13(t-1) = - d'PN_{14}(t-1) + \rho\ MN$$

The results, again, were not significant or meaningful. Since the relation we estimated was essentially a stable demographic relation, the lack of success indicates that the data are inconsistent.[37]

(23) Labor force participation

$$LF = \underset{(.019)}{-68.39 + .5121\ PN}$$

$R^2 = .9876\ (.9863)$ $\quad s = 3.42$ $\quad \bar{y} = 256.1$ $\quad D\text{-}W = .9942$

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[35] The same is not true, however, about the mortality rate of the group age 14 or over since Hawaii is known to have a younger population than the nation as a whole.

[36] Institute of Life Insurance, Life Insurance Fact Book, 1966, p. 110.

[37] Closer examination of the data revealed that observations for the three variables are indeed inconsistent for the majority of the years 1951-65.

Since we failed to estimate a relation for the determination of population age 14 or over, labor force participation was redefined in terms of total civilian resident population. Net civilian immigration was also retained as a regressor since age combination, and thus participation rate, may understandably be different from those of resident population. Information on both migration and labor force for earlier years is questionable.[38] And a preliminary analysis revealed that there is a systematic difference between labor force participation rate for 1951-65 and that for 1958-68. Consequently, the relation was estimated for 1958 to 1968. Again, net civilian immigration did not contribute to the explanation and was deleted. Nevertheless, the growth in labor force seems to be adequately explained in this abridged and simplified version, with a standard error amounting to only 1.3 percent of the sample mean of the dependent variable.

(24) Determination of wage rate

$$\Delta w1/w1_{-1} = 10.61 - \underset{(.330)}{1.556}\ (NU/LF)$$

$R^2 = .6492\ (.6200)$ $\quad s = .999$ $\quad \bar{y} = 4.09$ $\quad D\text{-}W = 2.932$

The wage rate is measured simply as total wage income of the private sector divided by total employment of this sector. Admittedly, this is only a rough approximate of the wage rate index or average hourly earnings, but a composite wage index is not available for Hawaii. The coefficient estimate for the price variable in the original formulation was very much smaller

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[38] In 1965, the State of Hawaii, Department of Labor and Industrial Relations revised its labor force estimates for 1958-63. Since the revision represented some change in methodology, the series before and after 1958 may not be strictly comparable.

than its standard error, so the relation was re-estimated as presented. Both variables are measured in percentage points. The result indicates that average wage income is quite responsive to the tightness of the labor market. In the period under consideration, both unemployment and wage increases averaged around 4 percent. If we consider a 3 percent unemployment rate as equivalent to full employment, then according to the estimated relation, the average wage would go up by 6 percent. Alternatively, if productivity grows at an average rate of 3.5 percent per annum, then to keep wage growth in pace the rate of unemployment would have to be at 4.5 percent.

(25) Transfer payments

$$\log UT = -1.643 + 2.350 \log PN65 \quad (.117)$$

$R^2 = .9710\ (.9681)$ $\quad s = 4.105$ $\quad \bar{y} = 61.57$ $\quad D\text{-}W = 1.335$

Transfer payments are well explained by the simple relation using only the number of civilian population age 65 or over. Unemployment has been removed from the original formulation since its coefficient estimate was smaller than its standard error. The lack of a significant relationship between the number of unemployed and transfer payments may be due to changes in the coverage of unemployment insurance.

Summary

As a whole, the estimated results of our model may be considered quite satisfactory. The original structural relations are sustained in most cases. Of the 25 equations considered, 3 cannot be estimated in their original form due to lack of information or data inconsistency. These are corporate profit,

employment in diversified manufacture, and labor force. Of the remaining, in only two cases are the hypothetical relations rejected by our data such that entirely different relations have to be formulated. The two cases are property income and employment in movie houses and recreation services. In a few other cases, a regressor was dropped because its coefficient was smaller than its standard error. But in most cases the cause can be traced to high multicollinearity or some inconsistency in our information on the variable involved.

The proportion of variations explained (R^2) is generally very high. This in iteslf is not unusual in time series analysis of aggregate relation, as long as both the dependent and the independent variables are moving monotonically in one direction. But in the several cases where values to be explained did fluctuate considerably, as in construction; in employment of such industries as pineapple, garment, recreation, construction, construction materials, wholesale and warehousing; and particularly in the growth of wage rates which changed direction seven times in 15 years, the fitted relations generally perform very well in capturing such fluctuations.

In view of the facts that the relations were formulated primarily on a priori ground without pretesting of any kind, the small number of regressors used in each equation, and restrictions imposed by the requirement of a recursive model, the agreement between data and model that we have obtained is rather encouraging. The real test of the usefulness of the structure obtained in this chapter rests in its ability to predict changes beyond the sample period. We will turn to this test in the following chapter.

Appendix: Determination of Construction Expenditures

As formulated in Chapter II, the model is self-contained in that explanatory variables used in any equation are either exogenous or are determined by some preceding equations. But in the estimated version just presented, one link has been broken due to an expediency imposed by data limitations. Equations (1) and (2) determine the permit values of residential and commercial construction. But what determines employment in construction and construction-related industries (equations (12) and (13)) is value of construction put in place. A bridge has to be built, therefore, to connect permit value and value of construction completed. Cenerally, it may take anywhere from one to two years for the realization of a permit value into construction, taking into consideration the lapse between the issuance of permit and the commencement of work as well as construction time. However, an earlier effort to relate the two in terms of annual observations was not satisfactory. Therefore, we experimented with a quarterly distributed lag relation. The distributed lag relation can be written in the following general form:

$$C = a_0P + a_1P_{-1} + a_2P_{-2} + \ldots + a_nP_{-n}$$

where C is private construction put in place in the current quarter, P is total permit values of private construction in the current quarter, P_{-1} is total permit values of last quarter, while P_{-2} and P_{-n} are respectively permit values 2 periods and n periods ago. We let the data determine the size of n--the number of quarters it takes for total permit value to be put in place.

Since 1960, permit values of private construction for all islands have been reported by the Dodge report,[39] and values of bid openings for government projects are reported in the General Contractors' Association of Hawaii's monthly publication Box Score. Values of construction put in place each month are reported in the tax base data of the Department of Taxation. However, no distinction is made in the tax base data between public and private construction. To estimate government construction put in place we used the following approximation:

$$H_g = 0.2\ B + 0.3\ B_{-1} + 0.3\ B_{-2} + 0.2\ B_{-3}$$

where H_g is public construction put in place, B, B_{-1}, B_{-2}, and B_{-3} respectively are values of bid openings of the current and the last 3 quarters. This relation implies that on the average a project is completed in 10 months after the contract has been awarded.[40] This value is then subtracted from the total value of construction put in place to obtain the value or private construction put in place. A method developed by Almon[41] for estimating distributed lags was employed to determine a relation between private construction put in place and various lagged values of permits. The relation was estimated for different lengths of lag ranging from 4 quarters to 10 quarters.

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[39] F.W. Dodge Corporation, Cooperative Report of Local Construction.

[40] This phasing formula was based on the work of the Department of Commerce, Bureau of the Census in this area. The same pattern was used in the Economic Research Center's income and expenditures studies (Oshima et al., Hawaii's Income and Expenditures, 1958, 1959, and 1960, p. IV-16).

[41] Almon, S., "The Distributed Lag between Capital Appropriations and Expenditures," Econometrica (January 1965), pp. 178-196. The method was found to be successful in predicting quarterly capital expenditures in manufacturing industries from past appropriations.

The coefficient of determination changed very little among the four structures estimated with n between 8 and 5. The one estimated with 6 quarters was chosen on grounds of statistical significance of parameter estimates and plausibility of the distribution of lags. The relation, estimated with 31 observations from the second quarter of 1961 through the fourth quarter of 1968, yields the following coefficient for current and lagged values of permits granted:

$$C = .0876\ P + .1901\ P_{-1} + .2476\ P_{-2} + .2335\ P_{-3} + .1551\ P_{-4} + .0526\ P_{-5}$$

$$R^2 = .9509$$

In other words, about 97 percent of the total value of permits issued in any given quarter will be realized during the current and the 5 following periods. The highest proportion of that value is put in place during the third and fourth periods.

CHAPTER IV

HISTORICAL FORECASTS AND SIMULATIONS

Performance of Historical Forecasts

The structures presented in Chapter III can be used to compute the estimates for the dependent variables associated with a set of values for the predetermined variables. As the estimated version of the model departs slightly from the *a priori* one discussed in Chapter II, it may be convenient for our discussion to review the set of predetermined variables used. Twenty exogenous and input variables appear in the model. They may be grouped as follows:

(1) number of overnight visitors, total visitor expenditures, total number of hotel rooms, average hotel occupancy rate

(2) total commodity exports, sugar production, pineapple production

(3) government civilian employment, civilian wage income from the public sector, public construction

(4) farm income, employment in diversified agriculture, number of nonagricultural self-employed

(5) civilian residential population, population age 65 or over

(6) construction cost index, Honolulu consumer price index

(7) property income from overseas investment, U.S. gross national product, number of privately owned residential housing units

In addition, the lagged values of the following endogenous variables also appear in the structure:

residential construction

commercial construction

proprietors' income

corporate profit tax collections

employment in the garment industry

average wage of the private sector

total personal income

Given a set of values for the exogenous and lagged endogenous variables listed above, values for the endogenous variables can be calculated in a straightforward manner from estimated equations. Our main concern in this chapter is to investigate the forecasting performances of this structure under various circumstances. Forecasts were made for 1966 to 1968. These years, in general, are outside the sample period. Therefore, the performance of our estimated model in predicting the course of the economy for these years is a good indication of how well a structure estimated for 1951-1968 will do in making forecasts for, say, 1969-1971.

One-year Forecast with Actual Values of Predetermined Variables

We started with the simplest situation of forecasting. Actual values of all predetermined variables were used.[42] Of course, this situation is never met in realistic ex ante forecasts. Many exogenous variables are not

[42]These values are found in the appendix.

known in advance. Even lagged values of the preceding period are generally not available at the beginning of a period due to time lag in the reporting of economic series. But such a hypothetical forecast focuses our attention on the ability of the equations to explain the behavior of the economy outside the sample by removing other sources of errors.

Forecast values for the 30 endogenous variables for the years 1966, 1967, and 1968 are presented in Table 5 along with their observed values.[43] The error is the ratio of the deviation to the observed value. Thus, an error of .09 means that the difference between the true value and the value forecasted is 9 percent of the former.

In general, the results are quite satisfactory, especially on the aggregate. In all three years the forecast error for personal income is 1 percent or less. The same is true for employment. Components of income are generally closely predicted.[44] Wage income of the private sector, which accounts for about half of the total civilian personal income, is forecasted to about 1 percent of the observed value on the average. Performances in forecasting components of employment are mixed. Employments for the following industries are predicted with less than 5 percent error on the average: retail trade, wholesale and trucking, transportation, garment, pineapple, and hotel. Employment in finance and real estate and employment in communication and utilities, on the other hand, are predicted with sizable errors which get

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[43]Except where indicated otherwise, income and expenditures are measured in millions of current dollars and employment is measured in number of persons.

[44]Transfer income for 1968 has been increased 13 percent from the level estimated in order to account for the effect of the 1967 amendment which gave a 13 percent across-the-board increase to cash benefits, effective the following year.

TABLE 5

RESULTS OF ONE-YEAR FORECAST

Variables	1966			1967			1968		
	Observ.	Est.	Error	Observ.	Est.	Error	Observ.	Est.	Error
RESIDENTIAL CONSTR	168.50	153.81	-0.09	124.30	147.04	0.18	207.20	203.07	-0.02
COMMERCIAL CONSTR	82.80	89.05	0.08	99.20	100.52	0.01	162.50	112.84	-0.31
RETAIL SALES	1297.20	1282.07	-0.01	1394.30	1395.50	0.00	1559.20	1511.19	-0.03
NONFARM PROP. INCOME	147.00	141.05	-0.04	152.00	151.88	-0.00	159.00	162.58	0.02
CORP PROFIT (TAX)	10.52	9.53	-0.09	11.20	10.32	-0.08	11.20	11.74	0.05
PROPERTY INCOME	205.00	210.68	0.03	228.00	227.89	-0.00	254.00	243.11	-0.04
SUGAR EMPT	12370.00	11990.55	-0.03	12020.00	11095.33	-0.08	11700.00	10768.50	-0.08
PINEAPPLE EMPT	8765.00	9194.49	0.05	8646.00	9163.84	0.06	8410.00	8712.94	0.04
HOTEL EMPT	7316.00	7779.04	0.06	8944.00	8937.74	-0.00	10734.00	10259.43	-0.04
GARMENT EMPT	2443.00	2442.05	-0.00	2580.00	2678.15	0.04	2760.00	2863.35	0.04
RECREATION EMPT	3423.00	3728.98	0.09	3765.00	3836.73	0.02	3959.00	4138.07	0.05
CONSTRUCTION EMPT	19378.00	17110.67	-0.12	16972.00	17841.64	0.05	19071.00	20176.28	0.06
CONSTR. MATERIALS	2513.00	2685.97	0.07	2453.00	2863.07	0.17	2612.00	3313.68	0.27
DIVERSIFIED MANUF.	8636.00	8914.27	0.03	8307.00	9283.83	0.12	8636.00	9627.10	0.11
RETAIL EMPT	40647.00	39584.70	-0.03	43341.00	41741.77	-0.04	45131.00	43780.05	-0.03
WHOLESALE-TRUCKING	16284.00	16518.14	0.01	16346.00	17409.62	0.07	16820.00	18037.17	0.07
FINANCE EMPT	13377.00	14042.47	0.05	14043.00	15509.14	0.10	14268.00	17436.60	0.22
TRANSPORTATION	9149.00	8918.30	-0.03	9503.00	9407.98	-0.01	10325.00	9850.16	-0.05
COMMUNICATION-UTIL.	5746.00	5403.45	-0.06	7164.00	5621.49	-0.22	7722.00	5823.52	-0.25
SERVICE EMPT	28374.00	25641.98	-0.10	29711.00	27254.36	-0.08	31843.00	28784.64	-0.10
UNCLASSIFIED EMPT	1779.00	2320.36	0.30	2065.00	1954.01	-0.05	2000.00	1660.97	-0.17
CONSTR COMPLETED	371.00	353.96	-0.05	367.00	388.12	0.06	442.00	462.09	0.05
LABOR FORCE (1000)	281.88	279.55	-0.01	293.39	292.10	-0.00	305.48	303.73	-0.01
PRIVATE WAGE RATE ($)	5438.00	5429.88	-0.00	5660.00	5714.80	0.01	6131.00	6033.09	-0.02
PRIV. WAGE INCOME	980.00	957.15	-0.02	1052.00	1054.94	0.00	1196.00	1177.85	-0.02
TRANSFER PAYMENT	120.00	117.25	-0.02	144.00	132.27	-0.08	163.00	158.39	-0.03
PRIVATE WAGE EMPT (1000)	180.20	176.28	-0.02	185.86	184.60	-0.01	195.07	195.23	0.00
TOTAL EMPT (1000)	272.73	268.81	-0.01	283.19	281.75	-0.01	296.60	295.89	-0.00
UNEMP RATE (%)	3.25	3.85	0.18	3.48	3.54	0.02	2.91	2.58	-0.11
PERSONAL INCOME	1999.00	1974.13	-0.01	2164.00	2153.98	-0.00	2428.00	2397.94	-0.01

larger over time. The volume of retail sales is accurately predicted. Private constructions (permit values) are also predicted fairly well considering that they are highly volatile. Thus, for example, the downturn of residential construction in 1967 was correctly predicted. The sizable error for commercial construction in 1968 is the result of an unusual upsurge of permits for commercial construction due to the impending change in zoning regulations.

Though forecast errors for many components of employment are of the same sign for the three years, in only three cases is there evidence that observations have progressively departed from the fitted relation over time. These are finance and communication employments mentioned earlier, as well as construction materials. We take this finding into consideration later when these relations are reestimated with the extended sample. The estimates for construction put in place, with an error around 5 percent, are surprisingly strong, considering its great variability and the many assumptions involved in developing the estimating formula.

Three-year Forecast Using Actual Values of Exogenous Variables

We now move one step closer to realistic forecasting by generating values of lagged endogenous variables internally. Specifically, we recall that the lagged values of 7 endogenous variables, including personal income and construction, are used as explanatory variables. In calculating our forecasts for 1967, the predicted values of these variables for 1966 were now used as inputs together with reported values of exogenous variables. Similarly, the forecasted values of these variables for 1967 were used as inputs for calculating the 1968 forecast. Though still short of the

complexities encountered in realistic forecasting, this is a fair measure of the efficiency of the estimated model in forecasting. By definition, determination of the exogenous variables is beyond the scope of the econometric model.

The results are presented in Table 6. Forecast values for 1966 are, of course, identical to those of the one-year forecast presented in Table 5. For the next two years, the quality of forecasts for those variables relating to the 7 lagged endogenous variables is generally adversely affected. This is to be expected since exact information has been replaced by estimates which contain errors. Fortunately, the differences are small in most cases. For 1967, the percentage error in absolute terms goes up by only one percentage point in almost all cases. Accuracy of forecasts for total employment and personal income is not notably affected. For 1968, the deteriorations of error ratios for individual components are more noticeable. For example, the unemployment rate is now underpredicted to a much larger extent. By a happy coincidence, this error cancels out the downward bias of the wage rate relation so that the forecast for personal income is actually closer to the observed value.

For the three-year projections of growth in income and employment, performance of the model is indeed impressive. Between 1965 and 1968, observed personal income went from $1,791 million to $2,428 million, an increase of $637 million. The forecasted increase is $630 million, an error of $7 million or 1.1 percent. Similarly, employment went up by 36.8 thousand over the same period. An increase of 37.2 is predicted in the model, also an error of 1.1 percent.

TABLE 6

RESULTS OF THREE-YEAR FORECAST

Variables	1966 Observ.	1966 Est.	1966 Error	1967 Observ.	1967 Est.	1967 Error	1968 Observ.	1968 Est.	1968 Error
RESIDENTIAL CONSTR	168.50	153.81	-0.09	124.30	144.80	0.16	207.20	201.78	-0.03
COMMERCIAL CONSTR	82.80	89.05	0.08	99.20	103.12	0.04	162.50	119.87	-0.26
RETAIL SALES	1297.20	1282.07	-0.01	1394.30	1390.09	-0.00	1559.20	1508.76	-0.03
NONFARM PROP. INCOME	147.00	141.05	-0.04	152.00	151.55	-0.00	159.00	162.43	0.02
CORP PROFIT (TAX)	10.52	9.53	-0.09	11.20	10.38	-0.07	11.20	12.07	0.08
PROPERTY INCOME	205.00	210.68	0.03	228.00	227.89	-0.00	254.00	243.11	-0.04
SUGAR EMPT	12370.00	11990.55	-0.03	12020.00	11095.33	-0.08	11700.00	10768.50	-0.08
PINEAPPLE EMPT	8765.00	9194.49	0.05	8646.00	9163.84	0.06	8410.00	8712.94	0.04
HOTEL EMPT	7316.00	7779.04	0.06	8944.00	8937.74	-0.00	10734.00	10259.43	-0.04
GARMENT EMPT	2443.00	2442.05	-0.00	2580.00	2677.35	0.04	2760.00	2945.17	0.07
RECREATION EMPT	3423.00	3728.98	0.09	3765.00	3836.73	0.02	3959.00	4138.07	0.05
CONSTRUCTION EMPT	19378.00	17110.67	-0.12	16972.00	17977.69	0.06	19071.00	20926.26	0.10
CONSTR. MATERIALS	2513.00	2685.97	0.07	2453.00	2886.27	0.18	2612.00	3441.59	0.32
DIVERSIFIED MANUF.	8636.00	8914.27	0.03	8307.00	9283.83	0.12	8636.00	9627.10	0.11
RETAIL EMPT	40647.00	39584.70	-0.03	43341.00	41695.33	-0.04	45131.00	43759.85	-0.03
WHOLESALE-TRUCKING	16284.00	16518.14	0.01	16346.00	17347.95	0.06	16820.00	18010.68	0.07
FINANCE EMPT	13377.00	14042.47	0.05	14043.00	15524.89	0.11	14268.00	17616.99	0.23
TRANSPORTATION	9149.00	8918.30	-0.03	9503.00	9407.98	-0.01	10325.00	9850.16	-0.05
COMMUNICATION-UTIL.	5746.00	5403.45	-0.06	7164.00	5621.49	-0.22	7722.00	5823.52	-0.25
SERVICE EMPT	28374.00	25641.98	-0.10	29711.00	27254.36	-0.08	31843.00	28784.64	-0.10
UNCLASSIFIED EMPT	1779.00	2320.36	0.30	2065.00	1954.72	-0.05	2000.00	1670.35	-0.16
CONSTR COMPLETED	371.00	353.96	-0.05	367.00	391.27	0.07	442.00	480.18	0.09
LABOR FORCE (1000)	281.88	279.55	-0.01	293.39	292.10	-0.00	305.48	303.73	-0.01
PRIVATE WAGE RATE ($)	5438.00	5429.88	-0.00	5660.00	5708.20	0.01	6131.00	6116.73	-0.00
PRIV. WAGE INCOME	980.00	957.15	-0.02	1052.00	1054.11	0.00	1196.00	1200.93	0.00
TRANSFER PAYMENT	120.00	117.25	-0.02	144.00	132.27	-0.08	163.00	158.39	-0.03
PRIVATE WAGE EMPT (1000)	180.20	176.28	-0.02	185.86	184.67	-0.01	195.07	196.33	0.01
TOTAL EMPT (1000)	272.73	268.81	-0.01	283.19	281.82	-0.00	296.60	296.99	0.00
UNEMP RATE (%)	3.25	3.85	0.18	3.48	3.52	0.01	2.91	2.22	-0.24
PERSONAL INCOME	1999.00	1974.13	-0.01	2164.00	2152.81	-0.01	2428.00	2420.86	-0.00

Comparison with Results from Other Methods of Forecasting

As far as we can tell, no documented method is yet used by any state agency or private research unit in Hawaii to forecast aggregate income or aggregate employment. And the Ferber-Sasaki study mentioned earlier is the only known attempt of forecasting components of employment and wage rates by statistical method.

The most straightforward technique of forecasting is the extrapolation of past trends. Among the commonly used trend relations, the exponential trend usually gives fairly close approximation to the growth path of income. Generally, the relation is written as

$$YP_t = YP_0 (1+r)^t$$

where YP_0 is personal income in the current period, YP_t is the predicted personal income t periods (years) from now, and r is the annual rate of growth. In other words, we assume that income will grow by a constant percentage every year just like a sum of money lent at a given rate of interest compounded annually. The relation can be estimated through a simple logarithmic transformation as

$$\log YP_t = \log YP_0 + t \log (1+r)$$

$$= b_0 + b_1 t \ .$$

The rate of growth r can be obtained from b_1 as

$$r = \text{antilog } (b_1) - 1 \ .$$

A relation like this was used by the Department of Taxation of Hawaii to

predict personal income for the projection of general fund tax revenue.[45]

In accordance with our general approach, we estimated the following trend relation for personal income for 1951-65:

$$\log YP = 2.781 + .0315\ t \qquad R^2 = .9793$$
$$(.0013)$$

This relation implies an annual rate of growth of 7.53 percent. Using this relation and personal income of 1965 as our base, the predictions for 1966 and 1968 are as follows:

Year	Observed Income ($ mil.)	Predicted Income ($ mil.) 1-yr.	3-yr.	Error (%) 1-yr.	3-yr.
1966	2005	1941	1941	3.2	3.2
1967	2165	2155	2087	0.5	3.6
1968	2428	2328	2244	4.1	7.6

The errors of forecast for both the one-year and the three-year predictions[46] are considerably larger than those of our model.

A more sophisticated forecasting formula for personal income was developed by Norman and Russell. After experimenting with various exogenous factors related to Hawaiian income on a priori ground, they chose the following

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[45] The relation they used in 1969 to project personal income through 1976 was

$$\log YP = 3.5687 + .0423\ t.$$

This implies an annual rate of growth of 10.23 percent.

[46] In the one-year prediction the observed income for 1965 was used to make forecasts for 1966, the observed income for 1966 was used to predict income for 1967, etc. In the three-year prediction only the observed income for 1965 was used.

as an expeditious model for predicting personal income in Hawaii:[47]

$$Y = \underset{(-1.6)}{-188.2} + \underset{(1.7)}{.414}\ POP + \underset{(5.8)}{.587}\ GNP + .826\ E_{-1}$$

where Y is Hawaiian quarterly personal income (in $ mil.), POP is Hawaiian residential population (in 1,000), GNP is U.S. gross national product at annual rate (in $ bil.), and E_{-1} is the lagged residual of the equation. Placed in parentheses below, regression coefficients are their t statistics. The relation was estimated with 36 observations from the second quarter of 1958 through the third quarter of 1967.

We made a one-year forecast on the personal income for 1968 using the above relation as well as the following observed values for Hawaiian population and U.S. gross national product:[48]

	POP (1,000)	US/GNP ($ bil.)
1968-I	760.9	835.3
1968-II	768.1*	858.7
1968-III	775.2	876.4
1968-IV	791.4*	892.5

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[47]Norman and Russell, op. cit., p. 97. The formula was introduced by the authors primarily for illustrative purpose, since forecasting income was beyond the scope of their study. We used it to make comparison because no other forecasting formula was available.

[48]Population figures for the first and the third quarters are those reported for January and July by the State of Hawaii, Department of Planning and Economic Development, in its Statistical Report No. 66 (April 30, 1969). The other two figures are the simple averages of the January and July figures. The GNP figures are from Survey of Current Business (October 1969).

The results are as follows:

	Observed Income	Predicted Income with E_{-1}	Predicted Income without E_{-1}
I	653	639	--
II	654	645	634
III	678	655	647
IV	721	683	663
Total	2706	2622	2583

Data on observed income are aggregated from monthly figures published in Business Week, not seasonally adjusted. The annual total came to within one million dollars of that in the Survey of Current Business. Understandably, when the error made in one quarter is taken into consideration in forecasting the next quarter, forecasting errors are reduced considerably. But since such information is not available when forecasting one year in advance, the second series presented above is relevant. In either case, the forecasts are not as accurate as those generated by our model.

Multiplier Analysis

Compared with the two simpler forecasting formulas considered, our model requires considerably more information as input, but the forecasts it generated have proved to be far more accurate and detailed. The payoff does not end here, however. The model can also be used to predict the effect of any change in the external conditions represented by exogenous variables. This ability

is relevant both for forecasting and for policymaking. More often than not, our vision on the future trend of some external factor is not definite but consists of a series of alternatives held with various degrees of confidence. For example, if at the end of 1968, we were to predict the growth in the number of visitors for 1969, the outcome would depend on several rather uncertain factors; namely, the award to airlines of new routes serving Hawaii, the inauguration of the new "jumbo" jet, and the troop level in Vietnam. What would appear on the horizon then are several possible rates of growth for tourism. And our model can indicate their implications in terms of income and employment. The policy application of such analysis is well recognized. Some of the exogenous variables are subject directly to governmental control such as government expenditures and public construction. Others can be influenced by government policy, such as the number of visitors, cost of housing, and population. The effect of many government policies can, therefore, be evaluated.

The full effects of many economic changes often take more than one year to work out. To account for this, lagged values of both input and endogenous variables appear in various places in the model. We can, therefore, distinguish between the impact effect and long run effect of a change. In our analysis below, impact effects refer to those realized in the same year in which the change takes place. The length of time relevant for analyzing the long run effects, on the other hand, is not the same for all changes. We will consider the five-year effect for illustration.

The Impact Effects of Expansion in Tourism

In the most general case, an expansion in tourism may be expected to affect three exogenous variables in the system, namely, the number of visitors (V), total expenditures of visitors (VE), and hotel occupancy rate (OR). As an example, we evaluated the impact effects on income and employment in 1966 resulting from an increase in visitor expenditures of $10 million by a larger number of overnight visitors. At the expenditure rates of 1966-68, the corresponding increase in the number of visitors would be 25,000, or a 3.5 percent increase for 1966. Assuming that they stayed for the average length, this would also bring about a 3.5 percent increase in hotel occupancy rate, or 2.9 percentage points on the basis of the then prevailing rate of 83.7. In sum, the package change in tourism was:

$$\Delta \text{ VE} = 10 \text{ (\$ mil.)}$$

$$\Delta \text{ V} = 25 \text{ (1,000)}$$

$$\Delta \text{ OR} = 2.9 \text{ (\%)}$$

This will be referred to as a unit of change for our analysis.

The results presented in Table 7 are quite interesting. Values originally forecasted for 1966 are presented in column 1 (under EY). Changes resulting from the one unit of hypothetical expansion in tourism appear in the second column (under P=1), followed by changes resulting from 2 units, 3 units, and 4 units of expansion. Consider the effects of a unit growth (P=1). The increase in tourism promotes retail sales by approximately the same amount, and it boosts employment for the following industries: hotel and rooming house, garment, retail, wholesale and trucking, finance and real

estate. In sum, an extra 25,000 visitors creates 390 new jobs, sends up the average annual wage rate by $11, and adds $4.74 million to personal income. Looking across the table, we note that the effects are approximately linear. That is, the effects of doubling the size of the expansion would approximately double the effects across the board. Thus, our study estimates an impact multiplier of 0.47 for tourist expenditures. An earlier study by the First National Bank of Hawaii (now First Hawaiian Bank) found that 55 percent of visitor expenditures became income to Hawaiian residents. They arrived at this result by analyzing the expenditure pattern of visitors and how the recipients of visitor dollars allocate their revenues. In the words of the author, "all expenditures...are traced to the point at which they either leak out of the State or become income to residents of the State."[49] The close agreement of the two results from different methods is indeed encouraging.

The Impact Effects of Expansions in Sugar and Pineapple Exports

The unit of expansion chosen for the sugar industry is as follows:

$$\Delta QS = 10 \text{ (1,000 tons)}$$

$$\Delta X = 1.5 \text{ ($ mil.)}$$

Ten thousand tons of raw sugar represents slightly over 1 percent of the average annual output level in the years 1966-68. At the 1968 price of $148 per ton, it commands an export value of approximately $1.5 million. The impact effects are presented in Table 8. The scope of the impact is considerably smaller than that of the tourism industry as fewer industries are

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[49] First National Bank of Hawaii, Department of Economic Research, The Impact of Exports on Income in Hawaii, p. 6, p. 35.

linked directly to the sugar industry. However, the size of the income-creating effect is identical to that of tourism. A $1.5 million increase in sugar exports and production results in an increase of $.71 million for personal income, or 47 percent of the increase in export value becomes income to the residents in Hawaii. The effect is again linear in spite of the logarithmic employment function for the industry.

The unit of expansion for the pineapple industry is a $5 million increase in both real output and export. The impact effects are shown in Table 9 with 32.6 percent of the increase in export revenue becoming income to residents.

Unlike the case with the expansion of tourism, the income-generating rates from expansions in the sugar and the pineapple industries are considerably lower than those reported in the First National Bank study cited above. The rates they estimated for sugar and pineapple were 67 percent and 53 percent respectively, compared with 47 percent and 32 percent. Part of the discrepancy may be due to the fact that we are not measuring exactly the same thing. The First National Bank study measures the percentage of the total export revenue that becomes personal income, or the average income-generating rate. Our study measures the percentage of an increment in export revenue that becomes personal income, or the marginal income-generating rate. Apparently, this difference is much more consequential for the sugar and pineapple industries than it is for tourism, a service industry. Also, the impact of commodity export is probably underrepresented in the estimated version of our model.

The Impact Effects of Government Expenditures

To evaluate the effects of an increase in government expenditures, we have to determine first the allocation of the extra spendings. In recent years, the state and local governments have been spending an average of 46 percent of their operating expenditures on wages and salaries to government employees. Thus, we defined the following as a unit of change in government operating expenditures:

Δ GE = 5 ($ mil.)

Δ W2 = 2.5 ($ mil.)

Δ NG = 373

Δ HG = 2.5 ($ mil.)

The impact effects are shown in Table 10. The impact multiplier at 1.2 is by far the largest of the changes considered so far. This is due to the way we assume the addition in expenditure is to be allocated. Half of it goes directly to wages; the remainder goes to construction, which also has a high income-generating effect.[50] Then the addition of over 500 jobs boosts the wage rate by $15 which adds much to personal income.

Dynamic Responses and Long-Run Multipliers

In computing the impact effects of external stimuli we have not taken full account of the secondary effects resulting from the spending and re-spendings of the additional income. This is generally referred to as the multiplier effect, suggesting that income generated by an increase in autonomous spending is often several times that of the initial increase.

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[50]The impact multiplier for construction was estimated to be .68.

TABLE 7

IMPACT EFFECTS OF EXPANSION IN TOURISM, 1966

Variables	EY	P=1	P=2	P=3	P=4
RESIDENTIAL CONSTR	153.812	0.0	0.0	0.0	0.0
COMMERCIAL CONSTR	89.047	0.0	0.0	0.0	0.0
RETAIL SALES	1282.066	10.10	19.96	29.59	39.00
NONFARM PROP. INCOME	141.053	0.63	1.24	1.84	2.43
CORPORATE PROFIT (TAX)	9.530	0.0	0.0	0.0	0.0
PROPERTY INCOME	210.682	0.0	0.0	0.0	0.0
SUGAR EMPT	11990.551	0.0	0.0	0.0	0.0
PINEAPPLE EMPT	9194.492	0.0	0.0	0.0	0.0
HOTEL EMPT	7779.035	132.89	265.78	398.67	531.56
GARMENT EMPT	2442.049	8.44	16.87	25.30	33.74
RECREATION EMPT	3728.985	0.0	0.0	0.0	0.0
CONSTRUCTION EMPT	17110.668	0.0	0.0	0.0	0.0
CONSTR MATERIAL EMPT	2685.966	0.0	0.0	0.0	0.0
DIVERSIFIED MANUF EMPT	8914.266	0.0	0.0	0.0	0.0
RETAIL EMPT	39584.695	89.19	175.82	259.90	341.68
WHOLESALE-TRUCKING EMPT	16518.141	118.93	234.93	348.10	458.64
FINANCE EMPT	14042.473	36.07	71.13	105.24	138.48
TRANSPORTATION EMPT	8918.297	0.0	0.0	0.0	0.0
UTILITIES EMPT	5403.453	0.0	0.0	0.0	0.0
SERVICE EMPT	25641.980	0.0	0.0	0.0	0.0
UNCLASSIFIED EMPT	2320.365	5.14	10.20	15.17	20.06
CONSTRUCTION COMPLETED	353.956	0.0	0.0	0.0	0.0
LABOR FORCE (1000)	279.555	0.0	0.0	0.0	0.0
PRIVATE WAGE RATE ($)	5429.883	11.29	22.38	33.30	44.04
PRIVATE WAGE INCOME	957.153	4.11	8.17	12.17	16.11
TRANSFER PAYMENTS	117.247	0.0	0.0	0.0	0.0
PRIVATE EMPT (1000)	176.275	0.39	0.77	1.15	1.52
TOTAL EMPT (1000)	268.805	0.39	0.77	1.15	1.52
UNEMPT RATE (%)	3.845	-0.14	-0.28	-0.41	-0.55
PERSONAL INCOME	1974.135	4.74	9.41	14.01	18.53

TABLE 8

IMPACT EFFECTS OF INCREASE IN SUGAR PRODUCTION AND EXPORT, 1966

Variables	EY	P=1	P=2	P=3	P=4
RESIDENTIAL CONSTR	153.812	0.0	0.0	0.0	0.0
COMMERCIAL CONSTR	89.047	0.0	0.0	0.0	0.0
RETAIL SALES	1282.066	0.0	0.0	0.0	0.0
NONFARM PROP. INCOME	141.053	0.0	0.0	0.0	0.0
CORPORATE PROFIT (TAX)	9.530	0.01	0.02	0.03	0.04
PROPERTY INCOME	210.682	0.0	0.0	0.0	0.0
SUGAR EMPT	11990.551	66.77	133.40	199.80	266.11
PINEAPPLE EMPT	9194.492	0.0	0.0	0.0	0.0
HOTEL EMPT	7779.035	0.0	0.0	0.0	0.0
GARMENT EMPT	2442.049	0.0	0.0	0.0	0.0
RECREATION EMPT	3728.985	0.0	0.0	0.0	0.0
CONSTRUCTION EMPT	17110.668	0.0	0.0	0.0	0.0
CONSTR MATERIAL EMPT	2685.966	0.0	0.0	0.0	0.0
DIVERSIFIED MANUF EMPT	8914.266	0.0	0.0	0.0	0.0
RETAIL EMPT	39584.695	0.0	0.0	0.0	0.0
WHOLESALE-TRUCKING EMPT	16518.141	0.0	0.0	0.0	0.0
FINANCE EMPT	14042.473	0.0	0.0	0.0	0.0
TRANSPORTATION EMPT	8918.297	0.0	0.0	0.0	0.0
UTILITIES EMPT	5403.453	0.0	0.0	0.0	0.0
SERVICE EMPT	25641.980	0.0	0.0	0.0	0.0
UNCLASSIFIED EMPT	2320.365	0.89	1.78	2.66	3.55
CONSTRUCTION COMPLETED	353.956	0.0	0.0	0.0	0.0
LABOR FORCE (1000)	279.555	0.0	0.0	0.0	0.0
PRIVATE WAGE RATE ($)	5429.883	1.95	3.90	5.85	7.79
PRIVATE WAGE INCOME	957.153	0.71	1.42	2.13	2.84
TRANSFER PAYMENTS	117.247	0.0	0.0	0.0	0.0
PRIVATE EMPT (1000)	176.275	0.07	0.14	0.20	0.27
TOTAL EMPT (1000)	268.805	0.07	0.14	0.20	0.27
UNEMPT RATE (%)	3.845	-0.02	-0.05	-0.07	-0.10
PERSONAL INCOME	1974.135	0.71	1.42	2.13	2.84

TABLE 9

IMPACT EFFECTS OF INCREASE IN PINEAPPLE PRODUCTION AND EXPORT, 1966

Variables	EY	P=1	P=2	P=3	P=4
RESIDENTIAL CONSTR	153.812	0.0	0.0	0.0	0.0
COMMERCIAL CONSTR	89.047	0.0	0.0	0.0	0.0
RETAIL SALES	1282.066	0.0	0.0	0.0	0.0
NONFARM PROP. INCOME	141.053	0.0	0.0	0.0	0.0
CORPORATE PROFIT (TAX)	9.530	0.04	0.07	0.11	0.14
PROPERTY INCOME	210.682	0.0	0.0	0.0	0.0
SUGAR EMPT	11990.551	0.0	0.0	0.0	0.0
PINEAPPLE EMPT	9194.492	151.86	298.99	441.75	580.43
HOTEL EMPT	7779.035	0.0	0.0	0.0	0.0
GARMENT EMPT	2442.049	0.0	0.0	0.0	0.0
RECREATION EMPT	3728.985	0.0	0.0	0.0	0.0
CONSTRUCTION EMPT	17110.668	0.0	0.0	0.0	0.0
CONSTR MATERIAL EMPT	2685.966	0.0	0.0	0.0	0.0
DIVERSIFIED MANUF EMPT	8914.266	0.0	0.0	0.0	0.0
RETAIL EMPT	39584.695	0.0	0.0	0.0	0.0
WHOLESALE-TRUCKING EMPT	16518.141	0.0	0.0	0.0	0.0
FINANCE EMPT	14042.473	0.0	0.0	0.0	0.0
TRANSPORTATION EMPT	8918.297	0.0	0.0	0.0	0.0
UTILITIES EMPT	5403.453	0.0	0.0	0.0	0.0
SERVICE EMPT	25641.980	0.0	0.0	0.0	0.0
UNCLASSIFIED EMPT	2320.365	2.02	3.99	5.89	7.74
CONSTRUCTION COMPLETED	353.956	0.0	0.0	0.0	0.0
LABOR FORCE (1000)	279.555	0.0	0.0	0.0	0.0
PRIVATE WAGE RATE ($)	5429.883	4.44	8.75	12.93	16.99
PRIVATE WAGE INCOME	957.153	1.62	3.19	4.72	6.20
TRANSFER PAYMENTS	117.247	0.0	0.0	0.0	0.0
PRIVATE EMPT (1000)	176.275	0.15	0.30	0.45	0.59
TOTAL EMPT (1000)	268.805	0.15	0.30	0.45	0.59
UNEMPT RATE (%)	3.845	-0.06	-0.11	-0.16	-0.21
PERSONAL INCOME	1974.135	1.62	3.19	4.72	6.20

TABLE 10

IMPACT EFFECTS OF INCREASE IN GOVERNMENT EXPENDITURES, 1966

Variables	EY	P=1	P=2	P=3	P=4
RESIDENTIAL CONSTR	153.812	0.0	0.0	0.0	0.0
COMMERCIAL CONSTR	89.047	0.0	0.0	0.0	0.0
RETAIL SALES	1282.066	0.0	0.0	0.0	0.0
NONFARM PROP. INCOME	141.053	0.0	0.0	0.0	0.0
CORPORATE PROFIT (TAX)	9.530	0.05	0.09	0.14	0.19
PROPERTY INCOME	210.682	0.0	0.0	0.0	0.0
SUGAR EMPT	11990.551	0.0	0.0	0.0	0.0
PINEAPPLE EMPT	9194.492	0.0	0.0	0.0	0.0
HOTEL EMPT	7779.035	0.0	0.0	0.0	0.0
GARMENT EMPT	2442.049	0.0	0.0	0.0	0.0
RECREATION EMPT	3728.985	0.0	0.0	0.0	0.0
CONSTRUCTION EMPT	17110.668	112.23	224.46	336.70	448.93
CONSTR MATERIAL EMPT	2685.966	19.14	38.28	57.42	76.56
DIVERSIFIED MANUF EMPT	8914.266	0.0	0.0	0.0	0.0
RETAIL EMPT	39584.695	0.0	0.0	0.0	0.0
WHOLESALE-TRUCKING EMPT	16518.141	0.0	0.0	0.0	0.0
FINANCE EMPT	14042.473	27.84	55.59	83.17	110.61
TRANSPORTATION EMPT	8918.297	0.0	0.0	0.0	0.0
UTILITIES EMPT	5403.453	0.0	0.0	0.0	0.0
SERVICE EMPT	25641.980	0.0	0.0	0.0	0.0
UNCLASSIFIED EMPT	2320.365	2.12	4.25	6.37	8.48
CONSTRUCTION COMPLETED	353.956	2.50	5.00	7.50	10.00
LABOR FORCE (1000)	279.555	0.0	0.0	0.0	0.0
PRIVATE WAGE RATE ($)	5429.883	15.43	30.88	46.30	61.73
PRIVATE WAGE INCOME	957.153	3.60	7.21	10.81	14.42
TRANSFER PAYMENTS	117.247	0.0	0.0	0.0	0.0
PRIVATE EMPT (1000)	176.275	0.16	0.32	0.48	0.64
TOTAL EMPT (1000)	268.805	0.53	1.07	1.60	2.14
UNEMPT RATE (%)	3.845	-0.19	-0.38	-0.57	-0.76
PERSONAL INCOME	1974.135	6.10	12.21	18.31	24.42

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We computed the multiplier effects of the various changes discussed at the end of five years. The computation was done as follows. The values of all the exogenous variables except those mentioned below were held at the levels observed in 1966. To make the simulation more realistic we allowed population to grow by 20,000 per year, which was the average size of growth for 1966-68. And, of course, the trend variable increased automatically. The economy was allowed to operate for five years under this condition. This is a simulation of how the economy would operate when all predetermined variables except population and trend were "frozen" at their 1966 levels. The simulation was then repeated incorporating one of those packages of changes introduced in 1966, and the predetermined variables affected were held at their new level throughout the five-year period. The differences at the fifth year between the two runs then measure the effects of the changes after they have had a period of five years to make themselves felt.

We did this for the three changes in the external sector that are discussed above. Their effects on selected variables are presented in Table 11. As expected, the changes are much larger and far more extensive then those reported under the impact effects. For example, take the case of tourism expansion and compare the first column in Table 11 with the column headed "P=1" in Table 7. The impact is felt initially only by those sectors directly related to tourism, such as the retail and the hotel industries. With the second table the effects have spread to other sectors, notably the construction industry. This is reflected in a much larger increase in employment, 633 compared with 390, and an even larger increase in wage rate. All told, the expansion of personal income resulting from a $10 million long-run

TABLE 11

FIVE-YEAR MULTIPLIER EFFECTS ON SELECTED ACTIVITIES
OF TOURISM OR TRADE EXPANSION

Activities	$10 mil. increase in visitor expenditures	$1.5 mil. increase in sugar export and production	$5 mil. increase in pineapple export and production
Residential Construction	1.525	0.221	0.545
Commercial Construction	0.546	0.143	0.445
Retail Sales	13.37	0.426	1.052
Construction Completed	1.754	0.318	0.867
Private Wage Rate ($)	68.41	10.33	25.667
Private Wage Income	16.63	2.458	6.180
Private Employment (1,000)	0.633	0.087	0.228
Unemployment Rate (%)	-.197	-0.027	-0.071
Personal Income	17.59	2.489	6.255

increase of visitor expenditures is now almost $18 million instead of the $5 million realized during the first year of the change. Similar stories occur in the cases of expansions in sugar and pineapple. The multipliers for them are respectively 1.7 and 1.3.

CHAPTER V

FORECASTS

Methodology

Revision of the Structure

First, we reestimated the structure presented in Chapter III using all the information at our disposal. Generally, this means extending our sample for each equation from 1951-65 to 1951-68.[51] This updating serves the dual purposes of improving our coefficient estimates through a larger sample as well as providing some indication on the stability of the structural relations. When the new coefficient estimates for a given equation are within two standard errors of their previous estimates, we may assume that no structural changes have taken place for that sector recently.

The new structure for making the 1969-73 forecasts is presented below. Of the 26 equations (1), (2), (3), (9), (21), and (23) are the same as those in Chapter III. Since data used in these relations are not available for earlier years, observations for 1966-68 were already employed in their first round estimations. Among the remaining relations, evidence of structural changes was detected in only three equations. The population parameter estimated for the determination of employment in food processing and printing-publishing (equation 14a) represents a significant departure from that obtained earlier. The same is true for the determination of employment in communication and utilities (equation 19).

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[51] The equation for transfer payments was estimated for 1951-67. A 13 percent across-the-board increase in benefit payments took place in 1968. We chose to handle the effect of this structural change by adjusting our estimates.

From the data, we note that in 1967 there was a sizable dip in the employment in food processing in the face of an expanding population, while there was a sizable increase in employment in communication and utilities. A linear function instead of a logarithmic one was picked for the determination of employment in finance and real estate. The trend variable was also dropped. It seems that employment in this sector has leveled off in recent years so that a logarithmic relation resulted in sizable overestimation of employment. For other equations, the use of larger samples has led to improved estimates in general. Coefficients of determination are higher in most cases, some substantially. In most equations t-ratios for coefficient estimates are higher, indicating that parameters are estimated with greater precision. For example, the coefficient of export in the profit equation, which was slightly smaller than its standard error in the relation estimated for 1951-65, is now 1.7 times its standard error.

Forecasts of Input Variables Made by Other Researchers

Forecasts of the following variables are obtainable for at least part of 1969-73: Hawaiian civilian population, number of overnight visitors, number of hotel rooms, and gross national product of the United States. The forecast values for 1969-73 and their sources are presented in Table 12.

On the basis of the number of overnight visitors and the inventory of hotel rooms, visitor expenditures and hotel occupancy rates were inferred as follows. The average length of stay for westbound visitors declined steadily during the period of observation, from 25 days in 1951 to 11.3 days in 1968. But the records also show that it has stabilized in recent years. The values for the last four years beginning with 1965 were 11.9,

STRUCTURE USED IN FORECASTING 1969-1973

(1) $\log HR = -2.306 + 0.3786 \log (\Delta PN)_{-1} + 1.226 \log YP_{-1}$ $R^2 = .7107$

(2) $HC = -104.2 + .8629\ \emptyset R_{-1} + .3597\ P1_{-1} + 8.856\ Pt_{-1}$ $R^2 = .8932$

(3) $\log SL = 1.672 + .0947 \log HR + .2409 \log VE + .1942 \log YP_{-1}$ $R^2 = .9919$

(4) $P1 = -58.51 + 0.2047\ PN + 0.0467\ SL$ $R^2 = .9872$

(5) $Pt = -0.7621 + 0.0183\ H + 0.0126\ X$ $R^2 = .9415$

(6) $P2 = -167.5 + 2.001\ HN$ $R^2 = .9870$

(7) $\log n1 = 2.190 + 0.7294 \log Q_s - 0.0219\ t$ $R^2 = .9766$

(8) $\log n2 = 3.539 + 0.2713 \log Q_p - 0.0081\ t$ $R^2 = .8966$

(9) $n3 = -1837 + .5568\ RN + 45.82\ OR - 196.3\ t$ $R^2 = .9806$

(10) $n4 = 258.5 + 0.8842\ n4_{-1} + 0.1663\ V$ $R^2 = .9680$

(11) $\log n5 = -0.0636 + 1.402 \log GNP - 0.0255\ t$ $R^2 = .8793$

(12) $n6 = 2793 + 82.90\ H - 80.80\ t$ $R^2 = .9823$

(13) $n7 = -521.9 + 14.89\ H + 11.73\ t$ $R^2 = .9336$

(14a) $n8a = 845.9 + 7.672\ PN$ $R^2 = .7790$

(14b) $\log n8b = -0.5073 + 1.371 \log PN$ $R^2 = .8248$

(15) $\log n9 = 3.097 + 0.4137 \log SL + 0.0144\ t$ $R^2 = .9924$

(16) $\log n10 = 1.637 + .8311 \log SL$ $R^2 = .9637$

(17) $n11 = -7173 + .3171\ (n9 + n10) + 12.58\ H$ $R^2 = .9825$

(18) $n12 = -7668 + 28.99\ PN - 186.7\ t$ $R^2 = .9890$

(19) $n13 = -5294 + 17.20\ PN$ $R^2 = .8585$

(20) $\log n14 = -0.8833 + 1.875 \log PN$ $R^2 = .9648$

(21) $\log (n15/ns) = 2.658 - 0.0958\ t$ $R^2 = .9597$

(23) $LF = -68.39 + 0.5121\ PN$ $R^2 = .9876$

(24) $(\Delta wl/wl_{-1}) = 10.67 - 1.587\ (NU/LF)$ $R^2 = .5597$

(25) $\log UT = 0.4658 + .7574 \log PN65 + .0255\ t$ $R^2 = .9848$

TABLE 12

PROJECTED VALUES OF PRELIMINARY VARIABLES USED IN PRELIMINARY FORECASTS

Variables	1969	1970	1971	1972	1973
Civilian resident population[a/]	744.4	764.6	783.2	802.3	821.8
Population age 65 or over	41.6	42.6	43.7	44.8	45.9
Total number of hotel rooms[b/]	25761	34010	41725	46575	51083
Average hotel occupancy rate (%)	82.3	71.2	62.9	61.2	63.2
Number of overnight visitors[c/]	1383	1579	1710	1858	2104
Total visitor expenditures	604	716	798	893	1043
Pineapple production ($ million at 1947-49 price)	99	99	99	99	99
Sugar production (1,000 tons)	1219	1219	1219	1219	1219
Total commodity exports	385.3	393.4	402.7	408.8	415.8
Public construction completed	183.1	183.1	183.1	183.1	183.1
Government civilian employment	69880	71511	73715	76004	78389
Civilian wage income from the public sector	524.1	548.2	577.5	607.6	638.5
Income from overseas investments	127	141	156	174	192
Farm income	40.6	42.2	43.9	45.6	47.4
Farm employment	6213	6213	6213	6213	6213
Number of nonagricultural self-employed	26080	26852	27563	28293	29037
Construction cost index (50-54=100)	228.9	247.2	259.6	272.6	286.2
Honolulu consumer price index (Dec. 63=100)	117.5	122.5	124.5	128.5	132.5
Gross national product of U.S. ($ billion)[d/]	927	993	1063	1138	1219

[a/] State of Hawaii, Department of Planning and Economic Development, "Interim Revision of Population Projections in the State General Plan" (November 24, 1969).

[b/] The first three observations were based on Hawaii Visitors Bureau, Annual Research Report (1968), p. 28. The last two figures were obtained by assuming that the number of hotel rooms will grow at the average growth rate of visitors for the two previous years.

[c/] R. C. Schmitt, Hawaii's Tourism Research (1968), p. 66.

[d/] National Planning Association, National Economic Projection Series, Report No. 69-N-1 (1969), National Economic Projections to 1978/79, p. 120.

Methods for deriving the remaining projections are described in the text.

11.7, 11.3, and 11.3.[52] We assumed, therefore, that the average length of stay will be stabilized at 11 days for the forecast period. Consequently, total visitor days would grow at the same rate of visitors. Average visitor expenditure per day was also quite stable in recent years. They were $39.0, $41.7, and $39.6 for the years 1965, 1966, and 1967, respectively.[53] For the years 1968-73 we let it increase at the observed or predicted annual inflationary rate of the cost of living index for Honolulu.[54] The average length of stay, the average expenditure per day, and the number of overnight visitors allow us to compute total visitor expenditures. At the same time, the growth of total visitor days and the growth of the total number of hotel rooms allow us to infer the occupancy rate. The results are shown in Table 12.

To predict the number of age 65 or over in the population, we note that this group behaved very systematically for the years 1960 to 1968, rising gradually and then leveling off, with a mean of 5.37 (percentage point) and a standard deviation of 0.226. For the years 1969-73 we held this proportion at 5.64, the average for 1966-68, and calculated their number from the projected population according to this ratio.

Estimation of Other Input Variables

Projections for the remaining predetermined variables are not available from outside sources. Procedures used to estimate their values through 1973

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[52] Hawaii Visitors Bureau, Annual Research Report, recent issues, Table 16.

[53] Robert C. Schmitt, Hawaii's Tourism Research (State of Hawaii, Department of Planning and Economic Development, November 1968), p. 33, p. 35.

[54] This inflationary rate was 4.1 percent for 1968 and 5.2 percent for 1969. The projected rates discussed in the next section are 4 percent for 1970 and 3 percent for 1971-73.

are discussed below. Where applicable, simple projecting formulas were used. The choice of these formulas was data oriented. A particular functional form was chosen primarily because it fit the sample data well. In some cases, estimates were made by judgment based on contemporary developments. The approach must, however, be considered expeditious and the resulting projections tentative. They can be improved on with a more extensive search of published materials and interviews with knowledgeable businessmen and government officials. Fortunately, revision of our forecasts with new values for predetermined variables can be done very easily.

Sugar, pineapple, and other exports. Both the sugar and the pineapple industries in Hawaii are confronted by shortages of land and labor. As a result, output has been quite stable for the last several years with variations accounted for primarily by weather conditions or labor disputes. Therefore, we assumed that annual output over the forecast period will remain at the average level achieved for 1966-68. The prices of cane sugar and pineapple depend primarily on their own supply conditions as well as the supply conditions of their close substitutes throughout the world. In the past, they did not follow the trend of other prices but have been fairly stable. For lack of better information we assumed that they will remain at the 1966-68 level. Other major exports are canned tuna, tropical agricultural products, garments, and scrap metal. Of these, garment is by far the most important. Export of tuna and scrap metal has been stagnant. The demand for the remaining "exotic" island products depends on the number of people introduced to them. The following relation was estimated for 1955-68 and used to predict the volume of exports other than sugar and pineapple:

$$XR = \underset{}{18.00} + \underset{(.004)}{.0471}\ V_{-1} \qquad R^2 = .9230$$

Government activities. Activities of the public sector are represented in the model by government civilian employment, wage income of civilian government employees, and public construction expenditures. We used the following relation estimated for 1951-68 to determine employment by state and local governments on the basis of population:

$$\log NG_s = \underset{}{2.807} + \underset{(.472)}{.5059}\ \log PN_{-1} + \underset{(.006)}{.0152}\ t \qquad R^2 = .9763$$

Reliable information for federal civilian employment was available only for the period 1958-68. The following relation was estimated:

$$NG_f = \underset{}{-7736} + \underset{(1.25)}{28.04}\ PN_{-1} \qquad R^2 = .9808$$

Defense-related civilian employment, however, is obviously determined by different factors which are difficult to quantify. It was not related in any meaningful way to the number of military personnel stationed in the Islands. However, for 1958-67, it was closely related to national defense spending as follows:

$$NG_d = \underset{}{11845} + \underset{(15.5)}{138.4}\ DS \qquad R^2 = .9091$$

where defense spending (DS) was measured in billions of dollars. For the years 1969-71 when some information on the defense budget was available, the above relation was used. For the remaining years we assumed that the defense budget will be held at the 1970 level as higher priority in our national policy will be given to other needs of the country. The total wage bill for

civilian government employees was inferred from employment using the following relation estimated for 1958-68:

$$W2 = -285.3 + 9.02\ NG + 9.424\ t \qquad R^2 = .9949$$
$$\qquad\qquad\quad (1.12) \quad (2.56)$$

Public construction completed is perhaps the most difficult to estimate by any simple relation. There is some prima facie reason to believe that given the capacity of the construction industry as well as the availability of funds, there will be some competition between private and public construction put in place in a rapidly growing economy. Consequently, with the level of demand held constant, the two kinds of construction would be negatively correlated. Accordingly, we tried to explain public construction in terms of lagged population changes and private construction expenditures. But the relation was not significant. The projected level of public construction has to be determined, therefore, by judgment.

Employment in diversified agriculture and nonwage workers. Employment in diversified agriculture consists of wage and salary employment other than sugar and pineapple, agricultural self-employed, and agricultural unpaid family workers. As reported by the Department of Labor and Industrial Relations, their total has been quite stable since 1960 without any notable trend. However, the data were estimated by intrapolation on the basis of census data for 1950 and 1960[55] and may contain sizable measurement errors. Any relation estimated from them, therefore, is of dubious value. We assumed that their

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[55]State of Hawaii, Department of Labor and Industrial Relations, "Description of Method of Estimating Labor Force Data " (January 1965), p. 1.

total will remain at the average level of 1966-68 for the next five years. The interaction between this employment and the rest of the economy in our model is confined to the rate of unemployment and wage rate. Since the size of this employment is so small relative to total employment, any alternative realistic assumption concerning the growth rate of such employment will have a negligible impact on the forecast values of other variables.

Other nonwage workers include nonagricultural self-employed, unpaid family workers, and domestics. Accurate information on them is available only in census years. Figures for the first two for other years were estimated by the Department of Labor and Industrial Relations from the number of employment units on the basis of their ratios reported in the 1960 U.S. Census. The number of domestic workers was estimated from population by the same principle.[56] However, the total figures obtained by them for the years 1958-68 are closely related to population alone in the following relation:

$$NS = \underset{(1.27)}{-2353 + 38.20\ PN} \qquad R^2 = .9901$$

which was used as our predictor.

Others. Other predetermined variables are property income from overseas investment, farm income from diversified agriculture, the total number of private residential housing units, consumer price indexes, and indexes for construction costs. We expect the volume of overseas investment held by residents of Hawaii to depend primarily on population of the State, whereas the profitability of such investment depends on the state of the national

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[56] Ibid., p. 2.

economy. This conjecture was borne out by empirical results. Income from overseas investment on a per capita basis is well explained by gross national product in the following relation estimated for 1951-68:

$$P3/PN = -28.19 + \underset{(.008)}{.2172}\ GNP(US) \qquad R^2 = .9790$$

The regressand is measured in dollars and the regressor is measured in billions of dollars. The relation was used to predict income from overseas investment on the basis of projected population and gross national product.

For one-year forecasting, the growth in the number of residential housing units can be predicted fairly accurately on the basis of the number of housing units authorized during the previous year. To forecast more than one year ahead some formula has to be devised. The most promising determinants seem to be real value of private construction put in place and permit value of residential construction for the pervious year. Both are generated by our model. However, neither variable succeeded in explaining the annual changes in residential housing units for 1958-68. It has been noted by other observers of the economy that at least since 1958, the year-to-year increase in housing inventory in Oahu and the annual growth in total employment tended to move together.[57] Accordingly, the following relation was estimated for 1958-68:

$$\Delta HN = 4.229 + \underset{(.08)}{.330}\ \Delta N \qquad R^2 = .7011$$

The estimated values calculated from this relation pick up most of the turning

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[57] Bank of Hawaii, Review of Business and Economic Conditions (December 1969), p. 8.

points during 1958-68. The relation was incorporated into our model for forecasting purpose.[58]

From 1960 to 1968, the cost of living index for Honolulu was increasing at the average rate of 2.4 percentage points per year.[59] Then it jumped 5.3 percentage points in 1969. In all likelihood, 1970 will remain an inflationary year as labor unions will press for sizable wage increases to catch up with inflation that has already taken place. We expect the cost-of-living index to go up another 5 percentage points during 1970. After that, we assumed that inflation will finally be brought under control. However, we expect the rate of inflation in the'70s to be generally higher as more resources are diverted to improve the environment. Cleaner air will be purchased through higher prices for automobiles and gasoline. We assumed that the cost-of-living index will be increasing at 4 percentage points per year for 1971-73, or approximately an inflation rate of 3 percent. The cost of construction index published by Builders Report Pacific increased at an annual rate of about 5 percent in recent years up to 1968. The cost increase for 1969 was estimated to be 13.7 percent by the Bank of Hawaii.[60] The demand for new housing in 1970 presents a mixed picture. On the one hand,

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[58] Since total employment is endogenous in our model, the relation has to be integrated into the structure of the model. It does not affect the recursiveness of the model as income is not used as a determinant.

[59] The index was based on December, 1963. The rate of inflation for this period was 2.5 percent.

[60] The value of total construction put in place in 1969 was estimated at $640 million. Of the $177 million gain over 1968, $77 million represented an increase in cost of construction. (Bank of Hawaii, Review of Business and Economic Conditions, December 1969) p.10.

there will still be a sizable backlog resulting from the large volume of authorized construction in 1968 and 1969; on the other hand, the tight money and the recent dip in tourism will have a dampening effect. Based on our expectation about labor costs for 1970 and general costs thereafter, we assumed an 8 percent increase for 1970 and a 5 percent increase for each of the succeeding years.

We were unable to estimate a statistically and theoretically acceptable relation to project income of farm proprietors. Since we have assumed that employment in diversified agriculture will remain stable for the forecast period and the scope of productivity change is likely to be limited, farm income was allowed to grow at 4 percent per year. This growth rate is higher than the rate of inflation projected for consumer prices in order to account for labor intensiveness in agriculture.

Forecasts for 1969-1973

Two sets of forecasts are presented below. In the first set, the forecasts were made using only information that was available by the end of 1968. The extraneous forecasts are those published before 1969.[61] Projections for the remaining variables were prepared according to procedures previously described using pre-1969 information. The only exceptions are the consumer cost index and the construction cost index. Since they are projected on the basis of judgment, we cannot unlearn what we already know. The second set

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[61]The population forecasts that we used were released in November, 1969. However, the birth rate projection was based on the national rate published by the Bureau of the Census in late 1967, and the projected net immigration was simply the 1960-1967 average. The projection could conceivably have been made in 1968.

consists of a revision of the forecasts for 1970-1973, utilizing all relevant information that had come to our attention by the time of computation (March, 1970).

Preliminary Forecasts for 1969-1973

Forecasts for 1969-1973 obtained from direct application of the procedure described in the last section are presented in Table 13.[62] The growth rates of personal income forecasted for the five years are: 9.0, 8.2, 10.0, 9.8, and 10.7 percent, or an average of 9.5 percent which is lower than the 10.7 percent observed for 1966-1968. The growth rate for employment is around 3.4 percent, which is quite a bit lower than the 4.5 percent observed for 1966-1968. In other words, the economy is expected to slow down from the brisk pace of the last few years. However, the growth rates of income and employment remain at satisfactory levels. The forecasts of the construction industry are interesting in the sense that they cannot be anticipated on a priori ground. While residential construction continues to grow, commercial construction levels off after 1970. Secondly, construction put in place falls absolutely in 1970 from the high level reached in 1969. After 1970, however, the growth is uninterrupted.

There is an important flaw in the overall picture of the forecasts: the demand for labor is outrunning its supply. This is reflected in the declining rate of unemployment, which is down to less than one percent in 1973. For all years, the forecasted unemployment rates are much lower than normal. This has a far-reaching impact. The annual increase in average wage is

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[62] In computing this set of forecasts, we assumed that the real value of construction completed for 1969 is at the average level of 1966-68. Thereafter, public construction will be maintained at that nominal rate until 1973.

TABLE 13

FORECASTS FOR 1969-1973

Variables	1969	1970	1971	1972	1973
RESIDENTIAL CONSTR	227.18	230.37	266.10	289.98	328.53
COMMERCIAL CONSTR	129.11	154.42	147.46	148.60	155.25
RETAIL SALES	1667.78	1769.30	1869.41	1972.74	2110.31
NONFARM PROP. INCOME	171.82	180.69	189.18	197.92	208.34
CORP PROFIT (TAX)	14.21	14.14	14.74	15.30	15.98
PROPERTY INCOME	259.95	274.19	290.91	306.51	322.99
SUGAR EMPT	10562.07	10041.75	9547.07	9076.74	8629.57
PINEAPPLE EMPT	8464.94	8309.28	8156.50	8006.51	7859.30
HOTEL EMPT	12548.89	16437.22	20156.51	22582.91	24988.43
GARMENT EMPT	2928.86	3110.76	3293.39	3479.48	3684.93
RECREATION EMPT	4086.16	4236.56	4392.86	4560.76	4728.86
CONSTRUCTION EMPT	21198.94	19334.66	19214.26	19078.21	19072.26
CONSTRUCTION MATERIALS	3282.38	2973.80	2978.42	2980.23	3005.40
DIVERSIFIED MANUF.	9248.00	9503.60	9739.82	9983.26	10232.68
RETAIL EMPT	47132.11	49067.82	51537.91	53760.23	56417.66
WHOLESALE-TRUCKING	18066.78	18330.25	18931.68	19283.84	19881.95
FINANCE EMPT	16528.10	16954.76	17922.72	18730.71	19774.39
TRANSPORTATION	10364.84	10763.72	11116.22	11483.20	11861.79
COMMUNICATION-UTIL.	7507.55	7854.93	8174.80	8503.27	8838.61
SERVICE EMPT	31772.54	33408.51	34948.70	36564.12	38248.36
UNCLASSIFIED EMPT	1401.83	1160.96	974.45	809.83	675.58
CONSTRUCTION COMPLETED	550.57	541.41	567.33	593.70	626.14
LABOR FORCE (1000)	312.84	323.19	332.71	342.50	352.48
PRIVATE WAGE RATE ($)	6602.74	7065.52	7668.88	8365.07	9209.58
PRIVATE WAGE INCOME	1354.18	1494.27	1695.47	1914.62	2190.95
TRANSFER PAYMENT	169.64	183.16	198.02	213.98	231.12
PRIVATE WAGE EMPT (1000)	205.09	211.49	221.08	228.88	237.90
TOTAL EMPT (1000)	306.99	315.74	328.26	339.07	351.22
UNEMP RATE (%)	1.87	2.30	1.34	1.00	0.36
PERSONAL INCOME	2647.28	2863.72	3150.98	3460.23	3831.30

considerably higher than in the late '60s and it is accelerating. Consequently, the share of wage income is increasing from year to year. Obviously, the economy is out of equilibrium.[63] The increase in the labor force is not sufficient to meet the increase in demand generated from the projected growth of the external and the internal sectors. Some adjustment has to be made.

Adjustment to the labor market can be made on the demand or the supply side or by some combination of both. In this case, we may reasonably expect that the adjustment will fall within certain limits on the supply side. In other words, with rising wages and employment opportunities, workers will be attracted or brought into the State.

The growth in the population projection we used was based on the assumption that net immigration will remain constant at the average level observed for 1960-67. Of course, this is not necessarily so. Given the small size of the Hawaiian economy relative to the nation, the labor supply to Hawaii may be fairly elastic. We believe that a realistic unemployment rate should be between 3 and 4 percent. After experimenting with alternative levels of net immigration, we found that an increased immigration of 5,000 persons per year would bring the average unemployment rate to around 3 percent. This new rate of population growth does not seem to be excessive. The greatest absolute increase in any year is only 25.2 thousand, compared with a 24.5 thousand increase in 1967.

The results of the 1969-73 forecasts are presented in Table 14. Unemployment averages 2.7 percent and is quite stable. The growth rate for wages

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[63] Also, our projected inflation rate is no longer realistic under such circumstances.

TABLE 14

FORECASTS FOR 1969-1973 (AUGMENTED PN)

Variables	1969	1970	1971	1972	1973
RESIDENTIAL CONSTR	227.18	252.37	287.88	313.16	348.82
COMMERCIAL CONSTR	129.11	154.79	149.91	153.51	160.95
RETAIL SALES	1667.78	1783.95	1881.88	1982.99	2112.89
NONFARM PROP. INCOME	172.84	183.43	192.83	202.49	213.58
CORP PROFIT (TAX)	14.21	14.31	15.14	15.76	16.46
PROPERTY INCOME	260.41	275.65	293.18	309.28	326.15
SUGAR EMPT	10562.07	10041.75	9547.07	9076.74	8629.57
PINEAPPLE EMPT	8464.94	8309.28	8156.50	8006.51	7859.30
HOTEL EMPT	12548.89	16437.22	20156.51	22582.91	24988.43
GARMENT EMPT	2928.86	3110.76	3293.39	3479.48	3684.93
RECREATION EMPT	4086.16	4236.56	4392.86	4560.76	4728.86
CONSTRUCTION EMPT	21198.94	19636.97	19920.96	19839.18	19834.99
CONSTRUCTION MATERIALS	3282.38	3028.09	3105.34	3116.90	3142.39
DIVERSIFIED MANUF.	9311.18	9630.49	9930.93	10239.07	10553.74
RETAIL EMPT	47132.11	49235.44	51679.75	53875.55	56446.29
WHOLESALE-TRUCKING	18066.78	18456.21	19036.57	19367.01	19902.21
FINANCE EMPT	16528.10	17093.73	18108.23	18909.16	19905.68
TRANSPORTATION	10509.79	11053.62	11551.07	12063.01	12586.55
COMMUNICATION-UTIL.	7593.54	8026.90	8432.76	8847.21	9268.55
SERVICE EMPT	32173.94	34232.52	36214.52	38291.80	40459.28
UNCLASSIFIED EMPT	1406.61	1173.11	989.58	824.68	689.16
CONSTRUCTION COMPLETED	550.57	550.42	589.46	618.72	652.47
LABOR FORCE (1000)	315.40	328.31	340.40	352.74	365.29
PRIVATE WAGE RATE ($)	6546.82	6917.42	7374.34	7846.59	8366.80
PRIVATE WAGE INCOME	1347.30	1478.27	1655.66	1828.88	2030.45
TRANSFER PAYMENT	169.64	183.16	198.02	213.98	231.12
PRIVATE WAGE EMPT (1000)	205.79	213.70	224.52	233.08	242.68
TOTAL EMPT (1000)	307.69	317.96	331.69	343.27	356.00
UEMP RATE (%)	2.45	3.15	2.56	2.69	2.54
PERSONAL INCOME	2641.89	2851.91	3117.09	3381.83	3679.20

estimated at 6.4 percent per year is only slightly higher than the 5.7 percent experienced during 1966-68 and is consistent with the higher inflation rate assumed. Proprietor income and property income are at a higher level but not enough to compensate for the fall of wage income due to lower wage rates. As a result, total personal income is now at a lower level for all years. The growth rate is also more moderate with the average growth rate now 8.7 instead of 9.5 percent. The shares of income from various sources are now fairly stable. The share of wage income from private sources is still increasing slightly over the years. This is to be expected since tourism is the most rapidly expanding sector and it is labor intensive. The patterns forecasted for other sectors are not appreciably affected by the change. Given the reliability of our projection about external demands, especially the expansion of tourism, the picture presented in Table 14 is a reasonable projection.

Revised Forecasts for 1969-1970

We have shown how the results of an initial projection can be used to revise some of the original assumptions about the predetermined variables to obtain a set of more consistent forecasts. Another standard procedure is to revise and improve our forecasts by making use of new information about the predetermined variables as soon as it becomes available.

At the time of this writing (March, 1970), preliminary information on some economic series for 1969 was available. The January, 1970 issue of the Bank of Hawaii's Monthly Review (subsequently referred to as Bank Review) provides provisional estimates for the 1969 values of a large number of our predetermined variables as well as their projections for 1970.[64] This

[64] Bank of Hawaii, Monthly Review (January 1970), p. 3.

information, along with similar information from other sources, was used to make a revised projection for 1969 and 1970.

There are a few significant discrepancies between the values of the predetermined variables used in our forecasting and the preliminary estimates given in the Bank Review. Expansion of the tourism industry was overestimated. This was true for both the number of hotel rooms as well as the number of visitors and their total expenditures. For the public sector, however, the values we used considerably underestimated the level of realized activities. In particular, the value assigned for public construction is $74 million below the one reported.[65] The population figure reported in the Bank Review (which was a provisional estimate by the Bureau of the Census) is smaller than the figure we used by some 8,000 persons. But that is primarily because the population figure we used for 1968 is larger than the census figure by about the same magnitude. Since there is prima facie empirical evidence to support our original 1968 figure,[66] we made no change in the population figure for 1969. Revisions for other predetermined variables were generally small. And the hotel occupancy rate that we estimated turned out to be exactly the same as that reported by the Bank of Hawaii. The new values used can be found in Table 15.

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[65]Unlike the case for other predetermined variables, this value had been arbitrarily set at the average level for 1966-68. This was a poor judgment since the public sector has been growing quite rapidly.

[66]We reestimated those equations in our model where population appears as a determinant using the alternative figure for civilian population in 1968. In all relations for which population predominated, estimates of the dependent variables for 1968 based on the new relation and the new population figure substantially underpredicted their true values. Reservation about the accuracy of the census population figures for recent years was voiced also in the Monthly Review, ibid., p. 5.

TABLE 15

VALUES OF PREDETERMINED VARIABLES USED FOR REVISED FORECASTS

Variables	1969	1970
Civilian resident population	744.4	764.6
Population age 65 or over	41.6	42.6
Total number of hotel rooms (mid-year)	24883 (-)	29965 (-)
Average hotel occupancy rate	82.3	74.1 (+)
Number of overnight visitors	1364 (-)	1475 (-)
Total visitor expenditures	580 (-)	651 (-)
Sugar production	1182 (-)	1243 (+)
Pineapple production	97 (-)	98 (-)
Total commodity exports	385.3	392.5 (-)
Public construction completed	256.7 (+)	269.5 (+)
Government civilian employment	71731 (+)	73362 (+)
Civilian wage income from the public sector	540.8 (+)	565.2 (+)
Income from overseas investments	127	141
Farm income	42 (+)	43.9 (+)
Farm employment	6009 (-)	6009 (-)
Number of nonagricultural self-employed	25450 (-)	26171
Construction cost index	228.9	247.2
Honolulu consumer price index	117.5	122.5
Gross national product of U.S.	932.3 (+)	987 (-)

Note: Revisions from those values used in preliminary forecasts are indicated by "+" (for upward revision) and "-" (for downward revision).

Source: See text.

The revised projections for 1969 are shown in Table 16. Compared with Table 13 personal income is now higher by $59 million, or a 2 percent increase; total wage employment of the private sector is up 2,400, about 1 percent. Changes in other sectors are generally small. For the few cases where preliminary information was available, which included the more important statistics, performance of the forecasts is generally satisfactory. Activities related to construction are estimated to within 5 percent of observed values. Projection of total employment is almost perfect. Total personal income, however, is underestimated by $83 million from the figure we compiled from the Bank Review.[67] The underestimation may be attributed to the unusually high rate of inflation for 1969. Since the structure used in our forecast was based on the experience of the last decade and a half, the effect of change in inflationary rate has not been fully accounted for in our projection. Particularly, our estimates for property income and wage income from the private sector will be too low.[68] The cost of living index for Honolulu went up 4.7 percent in 1969, compared with an average rate of 2.5 percent for 1960-68. The sum of estimates for the two categories of income was $1,656 million, and 2.2 percent of that comes to $36 million which corrects about half of our underestimation.

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[67]The information given in the Bank Review was for total personal income. We derived an estimate of civilian personal income by assuming that military payroll went up by the same percentage in 1969 as the growth of midyear military personnel in the State.

[68]Since the volume of retail sales is used to derive nonfarm proprietor income, the speed of inflation will be reflected in our estimate of proprietor income.

TABLE 16

REVISED FORECASTS FOR 1969 AND 1970

Variables	Observed*	1969 Estimated	Error	1970 Estimated
RESIDENTIAL CONSTR	239	227.18	-.05	245.58
COMMERCIAL CONSTR	126	129.11	.02	169.99
RETAIL SALES	1800	1651.57	-.08	1757.40
NONFARM PROP. INCOME		171.06		180.14
CORP PROFIT (TAX)		15.56		15.86
PROPERTY INCOME		262.38		279.94
SUGAR EMPT		10327.27		10185.59
PINEAPPLE EMPT		8418.20		8286.43
HOTEL EMPT		12059.99		14317.73
GARMENT EMPT		2925.70		2933.55
RECREATION EMPT		4123.32		4212.00
CONSTRUCTION EMPT		23864.60		22494.74
CONSTR. MATERIALS		3761.13		3541.34
DIVERSIFIED MANUF.		9248.00		9503.60
RETAIL EMPT		46942.05		48931.04
WHOLESALE-TRUCKING		17920.66		18227.70
FINANCE EMPT		16826.09		17358.49
TRANSPORTATION		10364.84		10763.72
COMMUNICATION-UTIL.		7507.55		7854.93
SERVICE EMPT		31772.54		33408.51
UNCLASSIFIED EMPT		1418.13		1170.29
CONSTR COMPLETED	620	624.17	.01	635.64
LABOR FORCE (1000)		312.84		324.99
PRIVATE WAGE RATE ($)		6717.30		7113.59
PRIVATE WAGE INCOME		1393.70		1546.87
TRANSFER PAYMENT		169.64		210.63
PRIVATE WAGE EMPT (1000)		207.48		213.19
TOTAL EMPT (1000)	310	310.67	.00	318.78
UNEMP RATE (%)		0.69		1.91
PERSONAL INCOME	2789	2706.58	.03	2967.68

*Information on residential and commercial construction is from the Dodge Report. The remaining information is from the Bank Review.

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The most disturbing result is the unrealistically low unemployment rate. Since our employment forecast is good, our labor force estimate must be too low. From Table 5 we note that in 1966-68[69] the labor force was underestimated by an average of 1,800. We may reasonably adjust our 1969 estimate upward by that amount. This will increase our labor force estimate to 314,600 and yield an unemployment rate of 1.2 percent. The unemployment rate is still too low; but until we have correct information on population, labor force, and total employment, this is all the reconciliation we can impose on our estimates.

On the basis of developments in 1969, revisions were made on the values of a number of predetermined variables used for the 1970 projection. They occurred primarily in the tourism and public sectors. Since recent reports from the visitor industry seem to indicate that the ebb in tourism may continue in the foreseeable future,[70] we used the lower projection of the Bank Review on the number of overnight visitors. It called for an 8 percent growth compared with a 14 percent growth used in our first set of projections. This changed tide has resulted in a drastic cut on planned hotel construction. As indicated in a recent survey by the HVB, the number of hotel rooms scheduled for completion has been reduced from 13,000, reported in a 1969 survey, to 6,000.[71] The total number of hotel rooms was adjusted downward accordingly.

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[69]Two important factors probably contributed to the unusually high labor force participation rate in 1966-68: (1) increase in net immigration--9,700 for 1966-68 compared with 5,036 for 1958-68, and (2) high birth rates in the earlier postwar years. This should serve to remind us that age distribution and migration should be considered in determining labor force, as intended in our original formulation.

[70]Visitor arrivals in January ran 4.7 percent behind last year. The February figure was off 1.8 percent.

[71]Honolulu Star-Bulletin, March 18, 1970, p. A-1.

Due to this sizable cut in the planned addition to visitor plant inventory, the occupancy rate projected for 1970, while substantially below that of 1969, was slightly higher than the one computed earlier. The total projected for visitor expenditures was, of course, substantially lower. New values for government employment and nonagricultural self-employed were computed by adding the projected growth to the actual number observed for 1969. Public construction was increased 5 percent from its 1969 level on the basis of changes in the State Capital Improvement Budget for fiscal years 1969-1971. For the pineapple and the sugar industries, the projections of the Bank Review were used. Civilian population on July 1, 1970 was projected at 774,000 in the Bank Review, which represents a 5 percent growth over July, 1969, compared with a 2.6 percent growth over the same period a year earlier and an average growth rate of 3 percent for 1966-68. We decided to use our earlier projection. Changes for other predetermined variables are small. The set of new values used is found in Table 15.

The observed values of residential and commercial construction and the provisional estimates of personal income for 1969 were used in preparing the revised projections for 1970. Published information on wage rates for 1969 was not yet available. We obtained some preliminary results from the Department of Labor and Industrial Relations which indicated that the average annual wage of employees covered by the Hawaii Employment Security Law went up 7.8 percent in 1969. Imposing this growth rate on the private wage rate observed for 1968, we obtained a wage rate of $6,609 for the year 1969. For the remaining lagged endogenous variables used in the model, namely, nonfarm proprietor income, corporate profit (taxes), employment in the garment industry,

total employment, and number of privately owned residential units, results of the revised projections for 1969 were used.

We made a 2 percent upward adjustment on the estimated values for property income and private wage income in order to allow for the higher rate of inflation projected for 1970. A 15 percent increase was added to transfer payments to reflect the most recent increase in benefit payments authorized by Congress.

The revised forecast for 1970 is presented in Table 16. Personal income is projected to increase by 6.4 percent from the figure reported in the Bank Review. A normal rate of growth is registered in most industries. Employment in the hotel industry is expected to grow by some 2,200.[72] Activities in construction, however, will fall appreciably from the record level reached in 1969. Total employment goes up 7,500, an increase of 2.4 percent. In calculating the labor force, we made the suggested correction by adding 1,800 to the estimated value.[73] The unemployment rate remains too low.

Revised Forecasts for 1971-1973

The horizon faced by the forecaster is particularly foggy now. It seems as though the experts are just as bewildered as the laymen about the course of the national economy in the next year or two. At the same time basic national priorities are being questioned, the outcome of which can bring about profound changes in national economic policy. Finally, the political situation in

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[72]This result, as well as the whole projection, rests on the hopeful assumption that the number of visitors will grow by 8 percent in 1970

[73]This adjustment is probably too conservative since the birth rate of Hawaii reached its peak in 1950-1954. See State of Hawaii, Department of Planning and Research (1962), Historical Statistics of Hawaii, 1778-1962, p. 10.

Southeast Asia, which is of particular concern to Hawaii, is very unstable. All these factors have a heavy impact on federal expenditures and tourism, which are the primary sources of income for Hawaii.

Consequently, it is not realistic to chart the precise course that each determining variable will take in 1971-1973. Instead, we constructed two sets of values for most of the predetermined variables. The high one is expected to prevail under the most favorable circumstances and the low one under the most unfavorable. Both alternatives, however, may be considered realistic with respect to past experiences or recent developments. The two sets of values may be interpreted as forming a confident interval in which the predetermined variables will most likely lie. The results are presented in Table 17 and discussed below.

The following predetermined variables showed relatively large variations in their annual growth rates during 1961-68: the number of visitors, the number of hotel rooms, public construction, and farm income. In addition, the future course of defense-related federal employment faces a wide range of possibilities due to the very uncertain military and political situation in the Far East. Consequently, there are wide spreads between the low and the high forecasts for these variables in Table 17. For the low forecast, the number of overnight visitors to the State is held constant at the level projected for 1970 by the Bank Review. In that year the 1,475,000 prospective visitors include some 261,500 servicemen and their families associated with the Rest and Recuperation (R&R) Program.[74] The latter group amounts to about 22 percent of other visitors. We assume that the gradual reduction of the R&R related visitors resulting from troop withdrawals from Vietnam

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[74] Monthly Review, op. cit., p. 4.

TABLE 17

REVISED PROJECTIONS OF PREDETERMINED VARIABLES FOR 1971-73

Variables	1971 High	1971 Low	1972 High	1972 Low	1973 High	1973 Low
Civilian resident population	793.2	783.2	832.3	802.3	871.8	821.8
Population age 65 or over	43.7	43.7	44.8	44.8	45.7	45.7
Total number of hotel rooms	35437	33789	40752	35479	46863	37253
Average hotel occupancy rate	68.3	65.7	65.6	62.5	63.0	59.5
Number of overnight visitors	1607	1475	1776	1475	1964	1475
Total visitor expenditures	744	683	847	704	966	726
Sugar production (tons)	1243	1243	1243	1243	1243	1243
Pineapple production (index)	98	97	98	96	98	95
Total commodity exports	418	418	430	422	444	426
Public construction completed	323	283	388	297	466	312
Government civilian employment	77.074	72.883	81.546	74.751	86.802	77.104
Civilian wage income from the public sector	607.8	570.0	657.6	596.2	714.4	629.9
Income from overseas investments	161	159	182	176	206	192
Income of farm proprietors	48.3	45.7	51.6	47.5	54.9	49.4
Farm employment	6.0	5.8	6.0	5.6	6.0	5.5
Nonagricultural self-employed	27.314	26.932	28.807	27.661	30.315	28.405
Construction cost index	259.6		272.6		286.2	
Honolulu consumer price index	124.5		128.5		132.5	
Gross national products of U.S.	1063		1138		1219	

will be offset by an increase in other visitors. Assuming that troop withdrawals and the phasing out of the R&R program are completed at an even pace by the end of 1973, the number of traditional visitors will have to increase about 6.7 percent per year for 1971-73 in order to take up the slack. So our assumption is a realistic one. Should the number of traditional visitors for 1971-73 increase at its 1961-68 rate (16.6 percent) while the number of R&R visitors is dwindling to zero, the high estimate will prevail. Visitor expenditures were inferred from the number of visitors by assuming an average length of stay of 10 days and allowing for the effect of inflation. We assumed that capital expansion of the hotel industry will, in general, be in step with the growth of visitors. With sluggish growth, the number of hotel rooms will be increasing at 5 percent per annum; otherwise it will grow at 15 percent. The low value for public construction incorporates an annual growth rate of 5 percent, which is just enough to offset the projected inflation rate of construction cost. For the high values we assumed that public construction will increase at the rapid rate of 20 percent experienced during 1964-69. For income of farm proprietors we used our earlier projected rate of growth to derive the low estimates. The high estimates were derived on the basis of outputs of the seven most important products of diversified agriculture as projected by Renaud.[75] Using their 1967 relative values as weights, we computed that the weighted average growth rates for these commodities in 1971-73 are, respectively, 2.9, 2.8, and 2.3 percent. To these

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[75]Outputs for 1969-75 were projected for the following commodities: beef and veal, pork, chicken (broilers), eggs, milk, macadamia nuts, and papaya. In 1967 these commodities accounted for 81 percent of total farm value of production of diversified agriculture in Hawaii. See Renaud, op. cit., p. 6.

rates we added another 4 percent to allow for the effect of inflation. Farm employment was held constant under the high estimate since increases in output were achieved in the past with a stable labor force. Under the low estimate, it is decreasing at 3 percent per annum. The level of defense-related civilian employment has been closely related with the size of American troops in South Vietnam. From a stable level it started to rise steadily in 1965, reaching its peak in 1968, and began to fall in 1969. Conceivably, the fall may continue so that by 1973 defense-related employment will be back to its 1963 level. This assumption is incorporated in the low estimate for government employment. On the other hand, the withdrawal of American forces from the Far East, particularly the scheduled return of Okinawa to Japan by 1972, may lead to relocation of military facilities and personnel in Hawaii.[76] As an alternative hypothesis, defense-related civilian employment will continue to fall in 1970 by the same magnitude as in 1969, but it will start to rise again in 1971. The rise will continue into 1973 at 6.6 percent per year, which was its average growth rate for 1966-68. This alternative hypothesis is incorporated in the high estimate for government employment.

In contrast, a single value was used for the following variables for both the high and the low projections: gross national product, consumer price index, construction cost index, and sugar production. Obviously, the first two variables will not be appreciably affected by the various turn of events discussed above. We do not have knowledge to determine the response of changes in construction cost to the volume of construction. In view of

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[76]This possibility was noted by economists of the Bank of Hawaii. See Bank of Hawaii, Review of Business and Economic Conditions (December 1969), p. 12.

production quotas and tariff protection, the sugar industry is expected to remain stable in the next few years as it has been in the past.

The future of the Hawaiian pineapple industry is far less certain than that of the sugar industry. The industry faces rising costs at home and stiffening competition from abroad. Pineapple acreage decreased 9 percent from 1962 to 1968. Recently some large local producers have started investing in foreign plantations.[77] Consequently, we assumed that real output will fall by 2 percent per year under the low estimate and that it will remain constant under the high estimate.

We retained the population projections used in the preliminary forecast as low estimates. The high estimates were obtained by iterations. We experimented with alternative accelerated rates of population growth until we found a population series which could supply a labor force consistent with the demand of the rapidly growing economy. Our results represent a 3.7 percent growth for 1971, 4.9 percent for 1972, and 4.7 percent for 1973.[78] The average rate of population growth in 1966-68 was 3 percent.

Values of the remaining variables were calculated by procedures described earlier. Population age 65 or over, government civilian employment (other than the defense-related), and nonagricultural self-employed were determined

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[77] State of Hawaii, Department of Planning and Economic Development, Hawaii Economic Review (Jan-Feb. 1970), p. 8.

[78] These adjustments have special implications for the size of the labor force. The labor force participation rate for the population as a whole has been estimated at 51 percent. This is probably too low for immigrants so we used a participation rate of 70 percent for that part of the population growth added under the high estimate.

by population.[79] Income from overseas investments was determined jointly by population and the U.S. gross national product. Average hotel occupancy rate was determined from the relative growth of hotel rooms and visitors. Value of sugar export was assumed to grow at 3 percent per year from the 1970 level predicted in the Bank Review, mainly as a result of rising prices. The same value was used for the high and the low projections. High estimate of pineapple export was held at $120 million, the 1969 value of production. For the low estimate, the value was decreased 2 percent per year for 1972 and 1973 to coincide with the assumed decline in output. Value of other commodity exports was determined by the number of visitors. Only the sum of these three categories of exports is shown in Table 17.

The two sets of projections for 1971-73 are presented in Table 18. Under the low projection, civilian personal income is advancing at an average rate of 7.2 percent per year, and total civilian employment is growing at 2.4 percent.[80] Both rates are very stable over the three years. But the rate of unemployment is going up gradually, suggesting that the increase in employment opportunities is not sufficient to absorb the growth of the labor force. The unemployment rate, however, remains quite low, and is not likely to have any significant impact on the rate of population growth. If this low rate of

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[79] It may be noted that the high estimates for population age 65 or over are the same as the low estimates. We assumed that the additions to population growth consist primarily of young immigrants.

[80] In computing income and its components, the following adjustments were made to both the low and the high estimates: property income and wage income from the private sector were revised upwards by 2 percent of the calculated values to account for the higher rate of inflation. Transfer payment was adjusted upward in two steps, respectively, 13 and 15 percent, to account for the two increases in benefits that came into effect subsequent to our sampling period.

TABLE 18

REVISED FORECASTS FOR 1971-1973

Variables	1971 Low	1971 High	1972 Low	1972 High	1973 Low	1973 High
RESIDENTIAL CONSTR	277.99	277.99	295.02	361.34	323.55	467.87
COMMERCIAL CONSTR	164.97	164.97	172.72	182.84	179.25	207.10
RETAIL SALES	1820.66	1858.57	1871.04	2006.86	1926.45	2170.34
NONFARM PROP. INCOME	186.90	190.72	193.17	205.65	199.75	221.38
CORP PROFIT (TAX)	17.28	18.01	18.07	20.41	18.92	24.02
PROPERTY INCOME	293.76	300.04	307.24	323.70	321.47	349.57
SUGAR EMPT	9683.82	9000.20	9206.75	9206.75	8753.19	8753.19
PINEAPPLE EMPT	8111.47	8134.07	7939.96	7984.50	7771.88	7837.68
HOTEL EMPT	15865.81	16902.61	16463.90	19542.12	17117.93	22629.45
GARMENT EMPT	3097.62	3119.56	3242.69	3312.14	3370.96	3513.69
RECREATION EMPT	4407.38	4407.38	4573.15	4573.15	4749.04	4749.04
CONSTRUCTION EMPT	23305.79	24583.19	23408.06	27113.64	23506.75	31201.50
CONSTR. MATERIALS	3713.25	3942.67	3757.87	4423.38	3801.83	5183.80
DIVERSIFIED MANUF.	9739.82	9867.16	9983.26	10367.34	10232.68	10876.21
RETAIL EMPT	50977.46	51414.00	52595.66	54142.88	54329.60	57076.21
WHOLESALE-TRUCKING	18520.41	18840.36	18453.87	19560.57	18431.39	20350.92
FINANCE EMPT	18235.61	18669.36	18755.42	20159.41	19325.36	21972.91
TRANSPORTATION	11116.22	11406.12	11483.20	12352.91	11861.79	13311.30
COMMUNICATION-UTIL.	8174.80	8346.77	8503.27	9019.18	8838.61	9698.48
SERVICE EMPT	34948.70	35790.21	36564.12	39169.81	38248.36	42728.05
UNCLASSIFIED EMPT	973.51	993.55	798.67	855.47	655.98	740.11
CONSTR COMPLETED	695.45	735.45	736.02	857.83	779.23	1044.86
LABOR FORCE (1000)	334.51	341.64	344.30	365.66	354.28	389.89
PRIVATE WAGE RATE ($)	7601.37	7679.62	8040.19	8247.92	8455.49	8921.15
PRIV. WAGE INCOME	1712.50	1765.74	1851.20	2034.09	1992.24	2371.55
TRANSFER PAYMENT	227.72	227.72	246.07	246.07	265.79	265.79
PRVTE. WAGE EMPT (1000)	220.87	225.42	225.73	241.78	230.99	260.62
TOTAL EMPT (1000)	326.49	335.80	333.68	358.14	342.00	383.74
UNEMP RATE (%)	2.40	1.71	3.08	2.06	3.47	1.58
PERSONAL INCOME	3195.58	3301.31	3417.38	3700.72	3652.54	4183.59

economic growth should persist beyond 1973, then the population expansion of the State would have to slow down. As a result of visitor plant increase, employment in the hotel industry will go up by 2,800 between 1970 and 1973, even though the number of visitors is held constant over this period. More than half of this increase will take place during 1971 when the 6,000 units of additional hotel units scheduled for completion will come into service. Consequently, a higher percentage of waged employment in the private sector will be employed by the hotel industry in 1973 than is the case in 1970. The share of employment in the trade sector (retail and wholesale) remains unchanged. Also, there is no change in the relative share of public versus private employment.

Under the high projection, the average growth rates for income and employment are 12.1 and 6.4 percent, respectively. The unemployment rates, in general, are considerably lower than those estimated under the low projection. This is reasonable. Should Hawaii grow at the unprecedented rate mentioned above, it is likely that the demand for labor will outstrip its supply as the cost of mobility between the State and any potential source of supply is high. Under the tight labor market projected, wage rate will be advancing at an average rate of 7.8 percent, which is 2 percentage points higher than that prevailing in 1966-68. In view of the higher inflationary rate that we have assumed, such increases are plausible. Therefore, we think that the population series used is consistent with the projected rate of economic growth. Between 1970 and 1973 the hotel and the construction industries are the big gainers as sources of employment, the sugar and the pineapple industries the big losers, while the share of combined employment in trade,

services, and utilities shows little change. As a whole, the economy will be less dependent on the public sector for employment in 1973 than in 1970.

The growth rates observed in 1966-68 for major summary measures of economic activities, such as personal income, total employment, and wage rate, lie about midway between those underlying the high forecast and those underlying the low forecast. This is to be expected in view of the way we determined the values for the determining variables. But even under the low forecast, the rates of growth during 1971-73 will still compare favorably with those experienced during 1951-65. On the other hand, the growth rates under the high forecast are of the same magnitude as those in 1968 and 1969. In other words, both forecasts are well within the realm of possibility. The spread between the low and the high forecasts for income and employment is around 3 percent for 1971, and it widens to about 13 percent by 1973. However, as the future draws closer and the outlook of major determinants becomes more definitive, we will be able to sharpen our forecast and narrow the band of uncertainty.

CHAPTER VI

CONCLUSION

We have estimated a system of equations to quantify the mechanism relating the flows of income and employment in Hawaii to the primary sources of demand originated externally from the public sector. The estimated structures, in general, are reasonable and stable.

The theoretical relations that we formulated in Chapters I and II came through the estimations with only minor revisions. Where data permit, the results estimated are in general agreement with theories and experiences.

Employment relations are well estimated. Interestingly, when output of an industry is well measured by the variable used, as in the cases of sugar, pineapple, construction, and trade, employment is log-linearly correlated with output. This result is in agreement with the conclusion of other empirical studies.[81] The following industries showed a statistically significant decline in their output/employment ratios over the period of the sample: sugar, pineapple, hotel, recreation, construction, and transportation. The reverse is true for retail trade and finance. The remaining industries do not show any significant trend.

These results, while not unexpected, are nevertheless interesting. They reflect the nationally observed phenomenon of a transition to a service

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[81] For example, see Y. Kaneko, "An Econometric Approach to Annual Forecast on Regional Economy by Local Government," Papers and Proceedings of the Second Far East Conference of the Regional Science Association (1965), Vol. 2, p. 129.

economy.[82] While the demand for services increases faster than income in an affluent society, the growth in labor productivity in the service-producing industries is significantly below that of both the agricultural and manufacturing industries. As a result an increasingly larger proportion of the labor force will be employed in service-producing industries.[83] This is shown most clearly in the employment equation in which service employment increases almost twice as fast as population.

Equations determining components of personal income were not as well estimated as employment equations. Data are more limited both in quantity and quality. Relations were estimated with smaller samples. Since observations on several variables were not available, proxy values were used. Coefficients were estimated with larger errors. The estimated result for the property income equation was not acceptable, and we had to settle for a substitute which does not relate to export.

A relation for determining labor force as a function of net immigration could not be estimated due to the lack of reliable information on migration. Consequently, an important linkage of our model is missing in the estimated version.

The predictive power of the model was tested rather extensively in Chapter IV since prediction is the primary objective of this study. The

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[82] For a discussion of recent developments in the service sector, see W.S. Sheldon, "The Service Sector -- Where the Action is," Federal Reserve Bank of Kansas City, Monthly Review (March 1970), pp. 3-11.

[83] Ibid., p. 5, p. 9. Service-producing industries include: transportation and public utilities, trade, finance, insurance and real estate, service and governments.

relations estimated for 1951-65 were used to make a one-year prediction and a three-year prediction for 1966-68. The overall performance in both cases was quite satisfactory. The model was particularly strong in predicting employment. This can be attributed primarily to the success in predicting the value of construction and retail trade, which account for over a third of total employment in the private sector.

The accuracy of the forecast just described suggests that the relations estimated for 1951-65 hold true for 1966-68. This was attested when the relations were reestimated for 1951-68. Major changes in coefficient estimates occurred only in the employment relations for two industries. Thus, although the economic growth rate almost doubled in those three years, the structure of the economy remained basically unchanged. The new structure was used to make the forecast for 1969-1973. When accurate information on predetermined variables was used our forecasts of income and employment in 1969 agreed closely with preliminary information.[84]

Tourism has been the main driving force of the State's growth and will likely continue to be in the foreseeable future. With a short-run multiplier of 0.47 and a long-run multiplier of 1.8, the increase in annual visitor expenditures from $131 million in 1960 to $580 million in 1969 has contributed a lion's share in the expansion of the Hawaiian economy.

The growth of tourism, however, is not an unmixed blessing. Tourism is labor intensive. To provide some idea of the magnitude of this problem, we

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[84] On page 14 of the April 1970 issue of Survey of Current Business, which came to my attention after the last chapter was written, personal income for Hawaii was estimated at $3,924 million, $76 million lower than the Bank of Hawaii estimate that we used earlier. Making the same allowance for military payroll (see p. 100), civilian personal income would be $2,703, which is very close to our estimate in Table 16.

considered its implications for 1971-73. We estimated that if tourism maintains its 1961-68 growth rate for 1971-73, there will be 600,000 more visitors in 1973 than in 1969 (Tables 15 and 17). If they average 10 days' stay there will be 16,438 more visitors per day. This will create 15,192 new jobs,[85] which require a population twice that size to fill. Altogether there will be 46,800 more people on an average day. Certainly we do not want all these additional people in Waikiki! If we are to rely on tourism as our major source of growth, an effort must be made to achieve geographic dispersion of the industry. At any rate, the cost of tourism-oriented growth in terms of the quality of life for Hawaiian residents must be carefully evaluated.

The work described in this report represents only a preliminary step in specifying a comprehensive econometric model for Hawaii. Econometric research in macroeconomic activities is necessarily a continuous effort. As additional information becomes available it should be incorporated to improve the accuracy of estimations. In all probability some part of the model has to be modified to accommodate changes in the economy. This is particulary pertinent for the present study because of the small sample we used and the rapid growth that the Hawaiian economy has been experiencing. We have already carried out one such updating in our analysis. In addition, our results have suggested several refinements for our model which can be incorporated quite easily once the required data are available.

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[85] This is based on the long-run effect of tourism expansion as presented in Table 11. There we estimated that the addition of 25,000 visitors per year will result in the creation of 633 new jobs. Since the multiplier analysis is designed for measuring the effects of a small change, it is not directly applicable here. The result may serve as a proxy, however.

We found that population growth in Hawaii cannot be forecasted independent of the rate of economic growth. Since the Hawaiian economy is highly service-oriented,[86] income and population tend to move closely together. This link has not been established in our model. In making forecasts we found it necessary to resort to an iterative procedure based on some arbitrary rate of unemployment. To restore this link we should estimate the response of net immigration to the demand condition of the labor market and the labor force participation rate of immigrants. To do this effectively we probably need to know the age distribution as well as the number of immigrants. As noted above, we do not have reliable information on net immigration. However, it appears that accurate estimates on net immigration by broad age groups can be compiled from vital statistics (births and deaths), school enrollments, and the number of retirees in the State.

The estimates of property income could be improved if we use separate equations for dividends, interest income, and rental income. In that way, the role of exports could probably be estimated more accurately. It seems that housing and taxation data should enable us to compile a fairly accurate figure on the annual change of rental income. Given the high concentration of corporate business in the State, an estimate of dividends can be compiled from corporation reports and taxation data.[87] Property income can then be determined as a residual from the total property income information that we have.

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[86] See Table 2.

[87] For example, it was estimated by the Bank of Hawaii that 95 percent of the dividends paid by the sugar industry and 100 percent of those paid by the pineapple industry became local income in 1960. See Bank of Hawaii, The Impact of Exports on Income in Hawaii, p. 28, p. 30.

The role of price has not been adequately accounted for, especially in the estimated version of the model. Empirical results suggest that wage changes respond to lagged price changes,[88] but we failed to obtain this result from our data. Consequently, our model is not equipped to handle the effect of change in the rate of inflation. In making forecasts for 1969-73 we found it necessary to introduce the effect of accelerated inflation in an heuristic manner. It is likely that wage rates for different industries respond with different lags. If so, we should divide private employment into several sectors and estimate separate relations for their wage determinations. Information on wage rates is available by sectors so this refinement can be readily implemented.

In brief, once we are ready to go beyond the confines of published data, the model can be improved through disaggregation. A highly aggregated variable tends to depend on a large number of other variables. It is not possible to include all of them in the equation due to multicollinearity and the smallness of our sample size. Consequently, the estimated structure contains specification errors. Also, with further disaggregation the logic of a recursive model stands on firmer theoretical ground, since there is likely to be strong interaction among highly aggregated variables. Several ways of extending the data for this purpose have been mentioned. In addition, the work on income and expenditure accounts for 1965-68 by Oshima and Shang at the Economic Research Center is now nearing completion. With the two volumes already in print,

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[88] For a discussion of some of these results, see M.K. Evans, Macroeconomic Activity, Theory, Forecasting, and Control, pp. 266-269.

we will soon have income and expenditure accounts for 11 consecutive years from 1958-68. They should provide valuable sources of information for disaggregating the variables in our study. The amount of work involved is considerable. But the apparent success of our initial effort seems to warrant additional investigation of our model within its general framework.

APPENDIX

DATA LISTING

I. OBSERVATIONS ON PREDETERMINED VARIABLES

Year	Aaa Bond Yield Monthly Average (Percent)	F Income of Farm Proprietors[a]	FHA Ceiling on Interest Rate on FHA Guaranteed Loans (Percent)	FVA Maximum Permissible Interest Rate on VA-Guaranteed Mortgage Loans (Percent)	GE Government Expenditures
1951	2.86	16	4.25	--	131.0
1952	2.96	18	4.25	--	136.8
1953	3.20	20	4.44	4.38	151.1
1954	2.90	21	4.50	4.50	163.5
1955	3.06	24	4.50	4.50	162.8
1956	3.36	26	4.63	4.50	171.9
1957	3.89	28	5.13	4.50	184.9
1958	3.79	28	5.25	4.69	220.1
1959	4.38	32	5.50	5.00	256.9
1960	4.41	39	5.75	5.25	291.0
1961	4.35	45	5.31	5.25	324.1
1962	4.33	46	5.25	5.25	361.2
1963	4.26	58	5.25	5.25	384.4
1964	4.40	48	5.25	5.25	397.5
1965	4.49	30	5.25	5.25	438.8
1966	5.13	34	5.73	--	526.0
1967	5.51	35	6.00	--	587.7
1968	6.18	39	6.38	--	639.3

[a] All income and expenditure figures are measured in $ millions.

Source: Aaa: U.S. Department of Commerce, Office of Business Economics, Survey of Current Business (various issues).

F: Unpublished tabulation from the U.S. Department of Commerce.

FHA, FVA: Data before 1963 are from D.S. Huang (1966), "The Short-run Flows of Nonfarm Residential Mortgage Credit," Econometrica, Vol. 34, No. 2, p. 455. Data after 1963 are from U.S. Savings and Loan League (1968), Savings and Loan Fact Book, Table 90.

GE: Bank of Hawaii, Annual Economic Review, 1968, 1969.

I. OBSERVATIONS ON PREDETERMINED VARIABLES (continued)

Year	HG Public Construction Completed	HN Private Residential Housing Units April 1 (1000)	MN Net Civilian Migration Years Ending June 30	NF Employment in Diversified Agri. (includes self-employed, unpaid family workers)[b/]	NG_d Defense-related Federal Civilian Employment
1951	--	111.8	-15,531	9,323	--
1952	--	114.9	-16,417	9,497	--
1953	--	117.8	-11,904	10,033	--
1954	--	120.6	-8,012	10,306	--
1955	--	123.6	1,265	10,425	--
1956	--	127.7	4,473	10,189	--
1957	--	131.5	9,641	10,049	--
1958	85.5	135.8	10,369	7,060	18,350
1959	61.6	139.9	955	7,050	18,450
1960	91.4	149.0	3,216	6,790	18,650
1961	65.9	156.3	2,841	6,530	19,220
1962	62.7	162.4	4,626	6,410	18,700
1963	94.6	167.9	596	5,790	18,420
1964	104.1	174.4	-50	5,770	18,540
1965	130.5	180.6	7,041	5,790	19,040
1966	120.0	189.6	3,751	6,080	20,730
1967	153.7	198.3	15,577	6,330	22,500
1968	210.2	206.0	7,537	6,230	23,120

[b/] Employment figures refer to annual average employments.

Source: HG: University of Hawaii, Economic Research Center (1967), Hawaii's Income and Expenditures, 1961-64, p. V-6. Recent data are from results of work in progress.

HN: Bank of Hawaii, Construction in Hawaii, 1967, 1969.

NM: State of Hawaii, Department of Planning and Economic Development, Statistical Report No. 66 (April 1969). Also unpublished tabulations provided by Mr. Robert Schmitt, State Statistician of Hawaii.

NF, NG_d: State of Hawaii, Department of Labor and Industrial Relations, Labor Force Estimates (published annually).

I. OBSERVATIONS ON PREDETERMINED VARIABLES (continued)

Year	NG_f Federal Gov't. Civilian Employ. (not related to defense)	NG_s State and Local Government Employment	NS Non-Agricultural Self-Employment (unpaid family workers and domestics)	OR Hotel Occupancy Rate in Waikiki	PN Civilian Population (as of July 1) (1000)
1951	--	14,754	19,285	--	469,236
1952	--	15,358	19,099	--	460,162
1953	--	16,020	19,099	--	463,727
1954	--	17,116	19,281	84.3	469,773
1955	--	17,055	19,447	81.5	485,679
1956	--	17,710	21,040	80.5	504,056
1957	--	18,244	21,175	84.6	527,247
1958	25,560	22,120	18,540	78.9	552,103
1959	26,200	21,410	19,130	88.3	566,675
1960	27,010	22,500	19,930	75.3	582,773
1961	27,290	23,100	20,590	70.1	600,132
1962	27,770	23,400	21,380	74.2	617,280
1963	27,910	24,980	21,990	77.4	630,441
1964	28,440	26,000	22,080	74.5	644,203
1965	29,570	28,150	23,400	82.1	665,877
1966	31,620	31,020	23,820	83.7	679,379
1967	33,900	32,440	24,390	90.0	703,925
1968	35,090	34,260	25,080	89.2	726,629

Source: NG_f, NG_s, NS: Ibid.

OR, PN: Bank of Hawaii, Annual Economic Review, 1968, 1969.

I. OBSERVATIONS ON PREDETERMINED VARIABLES (continued)

Year	P3 Return on Overseas Investments	PN65 Civilian Population Age 65 or Over (As of July 1)	Q_p Pineapple Production Real Output ($ mil.)	Q_s Sugar Production (1000 short tons)	RN Hotel Rooms (mid-year)[c/]
1951	22	22,000	85	996	2,100
1952	23	23,000	87	1,020	2,305
1953	26	24,000	102	1,099	2,668
1954	24	25,000	97	1,077	3,013
1955	26	25,000	98	1,140	3,608
1956	32	27,000	102	1,099	4,221
1957	34	28,000	96	1,084	4,541
1958	33	28,000	106	765	5,124
1959	37	--	100	975	6,148
1960	49	29,162	90	936	8,162
1961	51	31,000	90	1,092	9,857
1962	59	32,000	88	1,120	10,554
1963	66	33,000	89	1,101	11,159
1964	73	35,000	93	1,179	12,153
1965	86	36,000	98	1,218	13,865
1966	90	38,000	100	1,234	16,022
1967	101	40,000	104	1,191	17,937
1968	113	41,000	94	1,232	20,729

[c/] The original data are reported for December 31. The July 1 figures were obtained by simply averaging successive December figures.

Source: P3: Bank of Hawaii, Annual Economic Review, 1968, 1969.
PN65: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Population Estimates, Series P-25 (various issues).
Q_p: Value of pineapple production deflated by price index (1947-49=100) of canned pineapples. Production figures from Bank of Hawaii, Annual Economic Review, 1967-1969. Price figures from U.S. Department of Labor, Bureau of Labor Statistics, Wholesale Prices and Price Indexes.
Q_s: State of Hawaii, Department of Planning and Economic Development, The State of Hawaii Data Book. Figures for 1967-68 from Bank of Hawaii, Annual Economic Review, 1969.
RN: Hawaii Visitors Bureau, 1968 Annual Research Report.

I. OBSERVATIONS ON PREDETERMINED VARIABLES (continued)

Year	US GNP U.S. GNP ($ bil.)	V Overnight Visitors (1000)	VE Visitor Expenditures	W2 Civilian Wage Income of Public Sector	X Commodity Exports ($ mil.)
1951	328.4	51.6	29.0	159	238
1952	345.5	60.5	32.8	170	239
1953	364.6	80.3	42.6	177	266
1954	364.8	91.3	48.9	169	259
1955	398.0	109.8	55.0	178	270
1956	419.2	133.8	65.0	187	286
1957	441.1	168.8	77.6	200	279
1958	447.3	171.6	82.7	213	253
1959	483.7	243.2	109.0	236	276
1960	503.7	296.5	131.0	257	264
1961	520.1	319.5	137.0	272	282
1962	560.3	362.1	154.0	294	294
1963	590.5	429.1	186.0	320	334
1964	632.4	508.9	225.0	339	322
1965	683.9	606.0	265.0	364	331
1966	747.6	710.6	302.0	432	351
1967	793.5	1001.8	400.0	466	373
1968	865.7	1209.4	460.0	520	378

Source: US GNP: U.S. Department of Commerce, Business Statistics.
V: Bank of Hawaii, Annual Economic Review, 1968.
VE: Hawaii Visitors Bureau, Annual Research Report, 1968.
W2: Bank of Hawaii, Annual Economic Review (1968); U.S. Dept. of Commerce, Survey of Current Business (August 1969).
X: Bank of Hawaii, Midyear Report, 1951-60; Annual Economic Report, 1961-67; Annual Economic Review, 1968, 1969.

I. OBSERVATIONS ON PREDETERMINED VARIABLES (continued)

Year	XP Pineapple Export ($ mil.)	XR Export Other than Sugar and Pineapple	XS Value of Sugar Export ($ mil.)	p1 Consumer Price Index (Dec 1963=100)	p2 Construction Cost Index (1950-54=100)
1951	90.6	16.3	131.1	75.6	95.7
1952	91.6	13.4	134.0	77.8	99.8
1953	108.2	15.3	142.5	78.6	104.0
1954	103.4	28.1	127.5	79.3	107.6
1955	110.1	19.1	140.8	80.4	110.6
1956	116.8	25.6	143.6	81.5	118.4
1957	110.2	26.7	142.1	84.1	125.3
1958	124.3	26.0	102.7	88.0	132.3
1959	122.5	27.6	125.9	89.7	138.0
1960	113.3	28.1	123.0	91.8	142.0
1961	111.7	30.6	140.0	94.1	147.2
1962	108.9	31.1	154.0	96.7	154.2
1963	117.5	32.0	184.0	99.8	161.5
1964	120.0	41.0	161.0	100.3	168.0
1965	122.0	39.0	170.0	102.1	175.0
1966	123.0	46.0	182.0	104.9	185.9
1967	126.0	61.0	186.0	107.8	193.7
1968	122.0	61.0	192.0	112.2	201.3

Source: XP, XR, XS: Ibid.

p1: State of Hawaii, Department of Planning and Economic Development, State of Hawaii Data Book, 1967, 1968. U.S. Department of Labor, Consumer Price Index.

p2: Builders Report Pacific (January 13, 1969).

II. Observations on Dependent Variables

Year	H Construction Put into Place	HC Commercial Construction (Permit Value)	HR Residential Construction (Permit Value)	LF Civilian Labor Force[d/]
1951	88.0	--	31.0	191,678
1952	90.6	--	35.1	194,067
1953	90.4	--	33.8	196,142
1954	88.1	--	35.3	197,376
1955	94.2	--	42.6	199,276
1956	110.5	--	43.5	204,082
1957	133.6	22.8	52.5	207,564
1958	174.4	35.5	58.1	211,540
1959	206.8	38.4	92.4	222,980
1960	268.5	67.5	91.7	235,140
1961	263.0	54.0	79.3	242,850
1962	264.0	63.8	116.5	246,180
1963	265.0	46.7	96.4	250,880
1964	308.0	63.3	100.8	257,630
1965	339.0	82.8	150.4	269,020
1966	371.0	82.8	168.5	281,880
1967	367.0	99.2	124.3	293,390
1968	442.0	162.5	207.2	305,480

[d/] Labor force and employments are measured as annual average of monthly observations.

Source: H: State of Hawaii, Department of Taxation, Annual Report, 1951-1961; Tax Foundation of Hawaii, Government in Hawaii, 1961-1969.

HC, HR: Data for 1958-60 from University of Hawaii, Economic Research Center, Hawaii's Income and Expenditures, 1961-1964 (1967), pp. V-6-V-7; data for 1961-68 from Bank of Hawaii, Construction in Hawaii, 1967, 1968.

LF, N, NU, Nl: State of Hawaii, Department of Labor and Industrial Relations, Labor Force Estimates (annual).

II. Observations on Dependent Variables (continued)

Year	N Total Employment	NU Unemployed	N1 Wage and Salary Workers of the Private Sector	n1[e/] Sugar Industry
1951	183,400	8,278	114,768	22,410
1952	185,645	8,422	116,433	22,346
1953	186,600	9,542	118,211	22,223
1954	185,617	11,759	116,948	21,751
1955	189,352	9,924	119,749	20,955
1956	195,075	9,007	121,042	17,937
1957	199,831	7,733	125,248	16,815
1958	204,460	7,080	128,800	12,770
1959	216,140	6,840	141,640	15,396
1960	228,050	7,090	151,820	14,633
1961	232,910	9,940	155,400	14,155
1962	234,580	11,600	155,460	13,407
1963	238,860	12,020	157,960	13,092
1964	247,580	10,050	163,710	12,808
1965	259,770	9,250	172,650	12,650
1966	272,730	9,150	180,200	12,370
1967	283,190	10,200	185,860	12,020
1968	296,600	8,880	195,070	11,700

[e/] n1-n15 refer to employment by category.

II. Observations on Dependent Variables (continued)

Year	n2 Pineapple Industry	n3 Hotel and Rooming House Industry	n4 Garment Industry	n5 Recreational Establishments
1951	11,001	2,120	744	2,629
1952	11,186	2,283	873	2,848
1953	11,625	2,362	988	2,932
1954	10,434	2,535	1,138	2,881
1955	11,072	2,913	1,337	2,797
1956	11,140	3,176	1,551	2,934
1957	10,501	3,427	1,569	2,942
1958	10,600	3,611	1,704	2,595
1959	10,376	3,669	2,033	2,643
1960	10,396	4,235	2,379	2,925
1961	10,113	4,669	2,244	3,023
1962	8,903	4,629	2,214	3,110
1963	9,420	5,621	2,242	3,007
1964	9,005	5,834	2,218	3,307
1965	9,190	6,308	2,279	3,595
1966	8,765	7,316	2,443	3,423
1967	8,646	8,944	2,580	3,765
1968	8,410	10,734	2,760	3,959

Source: n1-n5: State of Hawaii, Department of Labor and Industrial Relations, Employment and Payrolls in Hawaii (annual).

II. Observations on Dependent Variables (continued)

Year	n6 Contract Construction Industry	n7 Construction Related Industries (Lumber, glass, clay)	n8a Food Processing and Printing-Publishing Industries	n8b Miscellaneous Industries
1951	10,229	643	4,446	2,447
1952	10,111	744	4,453	2,385
1953	10,294	718	4,459	2,362
1954	9,182	713	4,493	2,345
1955	9,310	752	4,281	2,445
1956	10,160	879	4,456	1,972
1957	10,978	1,077	4,521	2,473
1958	12,731	1,969	4,803	1,727
1959	14,936	2,266	5,481	1,884
1960	17,470	2,355	5,464	1,952
1961	17,113	2,331	5,913	2,095
1962	15,089	2,172	6,122	2,276
1963	15,380	2,243	5,237	3,085
1964	16,320	2,611	6,336	2,018
1965	17,953	2,378	6,216	2,159
1966	19,378	2,513	6,362	2,274
1967	16,972	2,453	5,673	2,634
1968	19,071	2,612	5,921	2,715

Source: Ibid.

II. Observations on Dependent Variables (continued)

Year	n9 Retail Trade Industry	n10 Wholesale Trade, Trucking and Warehousing Industry	n11 Finance, Insurance and Real Estate Industry	n12 Transportation Industry--Other Than Trucking and Warehousing
1951	19,320	10,832	3,805	5,584
1952	21,402	9,959	3,791	5,437
1953	21,780	10,423	4,173	5,426
1954	21,929	10,566	4,385	5,204
1955	23,053	10,940	4,629	5,443
1956	24,227	11,619	4,981	5,781
1957	25,018	12,284	5,442	6,132
1958	26,188	11,700	6,640	6,709
1959	28,781	12,147	7,339	7,227
1960	30,999	13,047	8,458	7,614
1961	31,763	13,997	9,368	7,734
1962	32,544	14,731	10,541	7,962
1963	33,483	14,682	10,681	8,097
1964	35,176	14,793	11,909	8,218
1965	37,769	15,360	12,921	8,534
1966	40,647	16,284	13,377	9,149
1967	43,341	16,346	14,043	9,503
1968	45,130	16,820	14,268	10,325

Source: Ibid.

II. Observations on Dependent Variables (continued)

Year	n13 Communications and Other Utilities	n14 Services--Other Than Motion Pictures and Recreation	n15 Non-Classified	PN14 Civilian Population Age 14 Or Over, July 1 (1,000)	Pt Corp. Profit (Corp. Tax (Collections)
1951	3,502	11,563	3,493	275	5.217
1952	3,597	12,493	2,525	257	3.764
1953	3,695	13,016	1,734	270	3.626
1954	3,685	13,266	2,441	283	3.642
1955	3,536	14,020	2,266	273	4.080
1956	3,597	14,982	1,650	285	4.869
1957	3,713	15,702	2,654	303	5.401
1958	4,161	15,820	5,072	318	6.552
1959	4,354	17,081	6,027	325	6.602
1960	4,641	18,185	7,067	368	6.826
1961	4,775	20,195	5,911	386	7.792
1962	4,860	21,949	4,951	398	6.683
1963	4,968	23,150	3,572	404	8.252
1964	5,049	24,479	3,629	415	8.853
1965	5,353	26,151	3,834	434	9.951
1966	5,746	28,374	1,779	446	10.525
1967	7,164	29,711	2,065	467	11.196
1968	7,722	31,843	1,620	--	--

Source: n13-n14: Ibid.

n15: Derived as N1 - (n1 + n2 + ... + n14).

PN14: U. S. Department of Commerce, Bureau of the Census, Current Population Reports, Population Estimates, Series P-25 (various issues).

Pt: Tax Foundation of Hawaii, Government in Hawaii (annual). The data have been adjusted to a calendar year basis as well as to the tax rate effective since 1966.

II. Observations on Dependent Variables (continued)

Year	P1 Non-Farm Proprietors' Income	P2 Property Income Earned Inside the State	SL Retail Sales	UT Transfer Payments	W1 Wage Income from Private Sector
1951	68	54	569.8	35	340
1952	81	55	562.3	36	357
1953	71	63	593.0	38	372
1954	69	78	589.1	43	375
1955	71	88	636.7	46	394
1956	77	90	680.9	47	416
1957	80	96	733.7	52	450
1958	85	98	739.0	56	495
1959	94	112	844.6	62	568
1960	102	138	948.2	66	651
1961	114	159	949.0	76	698
1962	118	158	1,027.6	85	715
1963	120	167	1,026.8	89	747
1964	125	181	1,101.8	91	819
1965	131	180	1,200.7	102	896
1966	147	205	1,297.2	120	972
1967	152	228	1,394.3	144	1,037
1968	159	254	1,559.2	163	1,180

Source: P1, P2: Unpublished tabulations from the U. S. Department of Commerce.
SL, UT, W1: Bank of Hawaii, Annual Economic Review, 1968, 1969.

II. Observations on Dependent Variables (continued)

Year	w1 Average Annual Wage of the Private Sector	YP Civilian Personal Income
1951	2,962	694
1952	3,066	740
1953	3,147	767
1954	3,206	779
1955	3,290	827
1956	3,437	876
1957	3,593	941
1958	3,843	1,009
1959	4,010	1,141
1960	4,288	1,303
1961	4,492	1,414
1962	4,599	1,475
1963	4,729	1,568
1964	5,003	1,677
1965	5,190	1,791
1966	5,394	1,999
1967	5,579	2,164
1968	6,049	2,428

Source: w1: Derived as W1/N1.

YP: Unpublished tabulation from the U. S. Department of Commerce.

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